**SUBCOURSE**
**SS0440**

**EDITION**
**A**

# U S ARMY SIGNAL CENTER AND FORT GORDON

# INSTALLATION, MAINTENANCE, RECOVERY, AND SERVICE

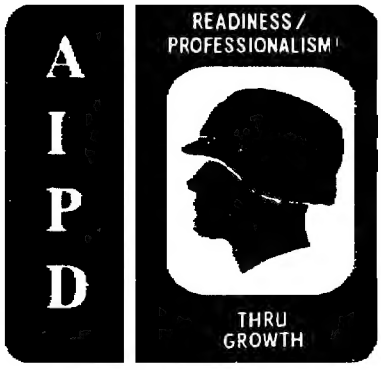
# OF

# TELEPHONE CABLE WD-1( )/TT or WF-16/U

**DEVELOPMENT DATE: MARCH 1994**

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM



# INSTALLATION, MAINTENANCE, RECOVERY, AND SERVICE OF TELEPHONE CABLE WD-1( )/TT OR WF-16/U

Subcourse Number SS0440

**EDITION A**

United States Army Signal Center and Fort Gordon
Fort Gordon, Georgia 30905-5000

13 Credit Hours

## SUBCOURSE OVERVIEW

This subcourse is designed to provide you with valuable information on the installation, maintenance, recovery, and servicing of telephone cable WD-1( )/TT or WF-16/U. The information is based upon TC 24-20, technical manuals, and resident training within the Signal School. This subcourse is presented in three lessons, each lesson building on the terminal learning objective indicated below.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

TERMINAL LEARNING OBJECTIVE

ACTION: You will learn the procedures to install, maintain, recover, and service WD-1( )/TT or WF-16/U.

CONDITION: You will be provided with lesson material, pencil, and paper. If you do not have access to the equipment, you will only need this subcourse. If access is available, you will need: FOR LESSON 1: a training area with preinstalled stepped stub poles, TE-33, gloves, tags, two each TA-312/PTs, BA-30s, reel unit RL-31( )/G, RL-159/U with telephone cable WD-1( )/TT, linesman bag, TE-21, lance poles PO-2, marline cord, hammer, wooden stakes, eye protection, shovel, GTA 11-1-2 clove hitch tie, GTA 11-1-3 aerial loop-knot tie, and GTA 11-1-4 ground loop-knot tie. FOR LESSON 2: a training area,

telephone cable WD-1( )/TT or WF-16/(U), TE-33, electrical or friction tape, TC 24-20, an installed telephone cable line WD-1( )/TT or WF-16/U, telephone set TA-312/PT, BA-30s, and TM 11-5805-201-12. FOR LESSON 3: a training area, a preinstalled WD-1( )/TT wire line, shovel, hammer, RL-31( )/G with WD-1( )/TT, gloves, linesman bag, TC 24-20, TM 11-5805-201-12, two RL-31( )/Gs, RL-159/U with recovered WD-1( )/TT, empty RL-159/U, TE-33, TA-312/PT, BA-30s, wire tags, grease pencil, clean rags, electrical or friction tape, and TM 11-3895-202-13.

STANDARD: Upon completion of this subcourse you will know the procedures for installing and tagging 1/4 mile of telephone cable using aerial, buried, surface, and an aerial road crossing using lance poles. You will have learned the procedures for repairing telephone cable WD-1( )/TT or WF-16/U by making a field expedient splice, locating and repairing a fault in telephone cable WD-1( )/TT, recovering 1/4 mile of WD-1 ( )/TT, and servicing, testing, and tagging recovered telephone cable WD-1( )/TT. You must achieve 70 percent on the written examination to receive credit for this subcourse.

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## LESSON 1

INSTALLATION

Critical Task 113-588-1022

## OVERVIEW

LESSON DESCRIPTION:

In this lesson you will learn about safety and first aid; what equipment is used in the installation; and installing the wire line to include surface, buried, and aerial construction on poles and lance poles.

TERMINAL LEARNING OBJECTIVE:

ACTION: The student will learn the procedures for installing a telephone cable line.

CONDITION: If you do not have access to the equipment, you will need only this subcourse. If available, a team will be provided a training area with preinstalled stepped poles, TL-13A, gloves, tags, two each TA-312/PTs, BA-30s, reel unit RL-31( )/G, RL-159:U with WD-1( )/TT, linesman bag, safety strap, body belt, lance poles, stakes, marline cord, shovel, grease pencil, and hammer HM-1 or rubber mallet.

STANDARD: Standard is met when knowledge of the skills required is demonstrated by correctly answering 70 percent of the questions on installation of telephone cable.

REFERENCES: The material in this lesson was derived from the following publications: TC 24-20, TM 11-3895-202-13, TM 11-5805-201-12, and FM 21-11.

## INTRODUCTION

Everyone is responsible for safety. Always watch for situations that could cause an injury on the job. Learn the steps necessary to assist an injured team member. The knowledge we have could save a life. In addition, we must know all we can about the equipment we use on the job. If we are unfamiliar with it we could injure ourselves. The installation of a telephone line is complex if you do not get an opportunity to do it very often.

Wire communications is one of the most dependable communications means. It includes the use of field wire, wire-laying and recovery equipment, cable, battery operated and sound powered telephones, switchboards, teletypewriters, multiplexers, and other associated or terminating equipment.

## PART A - SAFETY

1. Each soldier is responsible for accident prevention. Each individual must comply with the rules, regulations, and standing operating procedures (SOP). The soldier should correct or report unsafe conditions, report all accidents, use protective devices, warn others of known hazards, and encourage observation of safety regulations.

2. First aid. First aid is the immediate and temporary care given to the victim of an accident, injury, or illness before treatment can be administered by trained medical personnel. The field wireman is subject to many hazards. His work is performed in areas where medical personnel are not available. Therefore, it is important for him to be well-trained in first aid procedures. Wire personnel should be trained annually on cardiopulmonary resuscitation (CPR) procedures. (For more detailed information, refer to FM 21-11.)

3. General first aid procedures. When a field wireman has been injured, the person performing first aid must properly identify the injury and use appropriate first aid procedures. Improper first aid procedures may do more damage to the victim than the injury. Some of the general first aid procedures are listed below:

- Place the victim in a reclining position, head level with the body, until treatment requires movement.

- Check for hemorrhage, stoppage of breathing, wounds, burns, fractures, dislocations and other injuries. If the clothing must be removed, cut it away do not move the injured person.

- Provide immediate treatment for stoppage of breathing, pulse, serious bleeding, shock, fracture, and burns in that order.

- Determine which victims have injuries that require immediate attention and treat them first.

- Make the victim comfortable and calm.

- Keep the victim warm and treat for shock

- Keep calm. Unless it is absolutely necessary, do not move the injured person.

- Provide only necessary first aid, and be sure that nothing is done to cause further injury.

- Call a medical officer or an ambulance. Give the medical officer the following information: the location of the victim; the nature, cause, and probable extent of injury, the available supplies; and the type of first aid being given.

- Never give liquids to an unconscious person.

- Keep onlookers away from the injured person.

- Do not let the victim see his injury.

4. First aid for electrical shock. In an electrical shock accident, quick rescue and application of artificial respiration are extremely important. If an unconscious person is in contact with a wire and it is not definitely known that the wire has been de-energized, assume that the wire is live. This is a dangerous situation, since a live wire can send electric current through the body of the victim to the rescuer. Exercise extreme caution to ensure the live wire does not come in contact with the rescuer. Consider quickly but carefully the steps to be carried out in the rescue.

- Wear rubber gloves and, if possible, rubber footwear in a rescue work involving electrical shock.

- Pull the victim clear with a dry rope, or push wire clear with a dry nonmetallic tree pruner handle, board, or ladder.

**WARNING**

**Remove bracelets, watches, rings, or other metal objects from hands and arms before attempting to remove a live wire from a victim.**

- Use a nonmetallic tree pruner handle equipped with a wire cutter head or a pair of pliers to cut the wire on both sides of the victim.

- Treat for shock and if the victim is not breathing apply artificial respiration.

5. First aid for closed and open fractures.

a. In a closed fracture, the bone is broken but does not protrude through the skin. Improper handling of closed fractures may cause them to become open fractures. Give first aid for the closed fracture in the following manner:

- Consult a medical officer immediately.
- Do not move the injured person until a splint is applied to immobilize the fractured bone ends and adjacent joints.
- Control shock by keeping the victim warm and in a comfortable prone position.

b. In open fractures the bone may protrude through the skin. They are usually more serious than closed fractures because of infection and damage done to tissue around the bone. Treat an open fracture in the following manner:

- Consult a medical officer immediately.
- Check bleeding by applying hand pressure at a pressure point and a tourniquet.
- Apply a sterile dressing to the wound and bind it in place.
- Treat as for a closed fracture. DO NOT try to restore the bones to normal position.

c. For additional information on first aid, refer to FM 21-11. Self-aid and buddy-aid for nuclear, biological, and chemical (NBC) casualties are contained in FM 3-4.

6. Cardiopulmonary resuscitation. When a person's heart and lungs stop functioning, it is possible to save a life by using CPR. CPR provides temporary circulation and breathing for the victim. Chest massage is alternated with mouth-to-mouth resuscitation to stimulate the natural functions of the heart and lungs.

## PART B - EQUIPMENT USED IN INSTALLATION

1. This section is concerned with identifying the various pieces of equipment that you will need to accomplish your mission. There will also be technical characteristics presented, where they are available, for each item. (See Table 1-1.)

2. Telephone cable WD-1( )/TT. This cable has two twisted, individually insulated conductors. (See Figure 1-1.) The original WD-1( )/TT had separate conductors. The newer WD-1A/TT has the same two conductors but they are bonded together. (See Figure 1-2.) The conductors have the following characteristics:

- Four tinned-copper strands and three galvanized steel strands.
- Inner insulation of polyethylene and outer nylon insulation jacket (WD-1/TT only).
- Tensile strength of approximately 200 pounds (both conductors).
- Weight of 48 pounds per 1.6 kilometers (1 mile).
- Loss at one kilohertz at 68 degrees Fahrenheit is 2.5 decibels (dB) per 1.6 kilometers (1 mile) under wet conditions, and 1.5 dB per 1.6 kilometers (1 mile) under dry conditions.

Table 1-1. Characteristics of field wire and cable.

| Common term | Basic cable or wire | Assemblies | Length | Attn(dB) Per mile[a] (1.5 km) | Weight | Tensile Strength In lbs | Loading | Additional Information |
|---|---|---|---|---|---|---|---|---|
| Field Wire | ED-1/TT WD-1A/TT | | 1/4 mile (4 km) 1/2 mile (8 km) 1 mile (1.6 km) 2 1/2 miles (4.0 km) | 2.5 Wet 1.5 Dry | 48 lb per mile (1.6 km) | 200 | None | Inner insulation of polyethylene and outer nylon jacket WD-1TT only. Polyethylene cover. Stranded conductors, 4 copper, 3 steel. |
| Cable, Tel (Assault Wire) | WD-36/TT (Std A) | MX-6894/TT MX-6895 | 1/4 mile (4 km) 1/2 mile (8 km) | 5.9 Wet 3.6 Dry | 8.5 lb per mile (1.6 km) | 25 | None | Solid aluminum conductor # 23 AWG. FSN MX-6894-3895-089-7278. FSN MX-6895-3895-089-7279 |
| Wire, Tel (Four-Wire, field Wire | WF-16/U (LP) | | 1 mile (1.5 km) | 2.6 Wet 2.0 Dry | 62 lb per mile (1.6 km) | 200 | None | Conductors are copper-cadmium alloy, stranded. |
| [a]At 1 kHz unless otherwise indicated. | | | | | | | | |

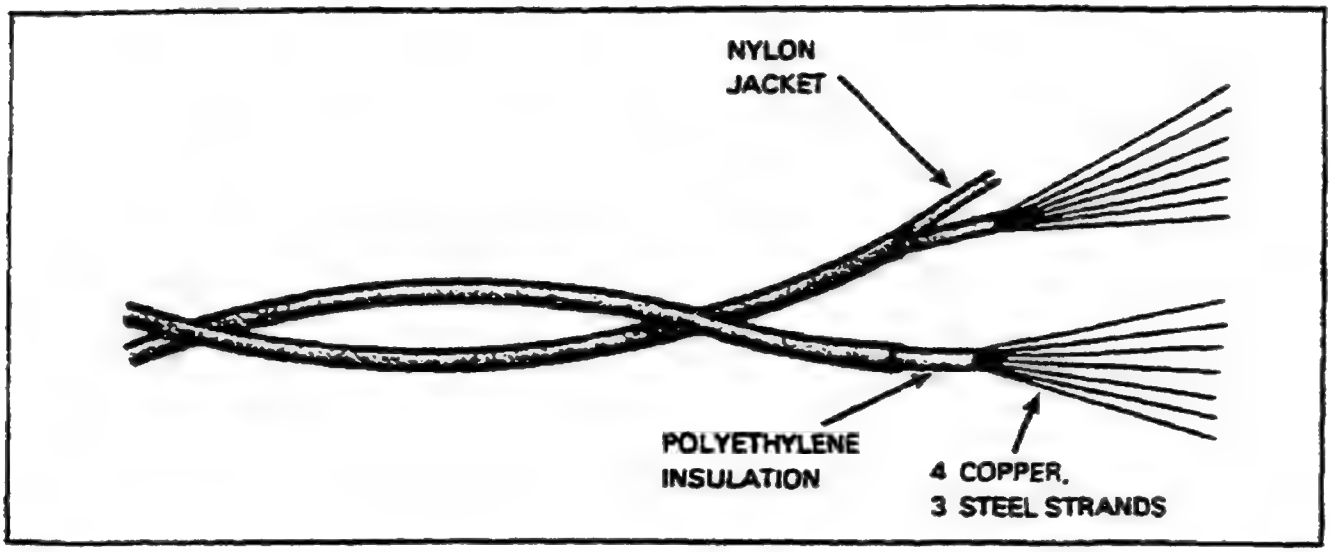


Figure 1-1. Field wire WD-l/TT

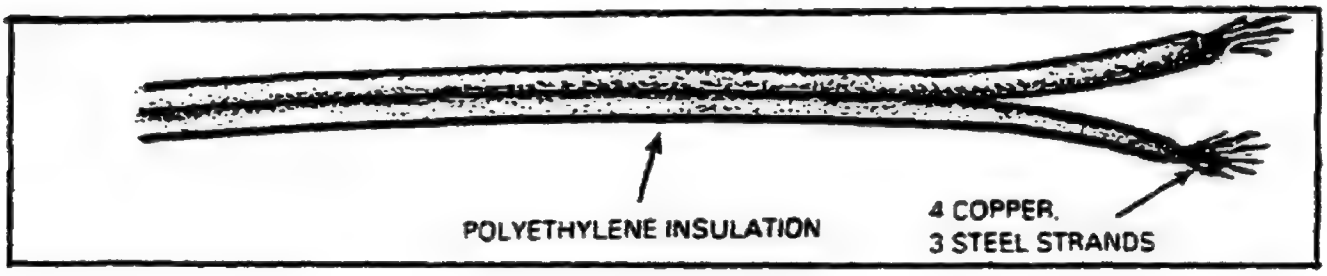


Figure 1-2. Field wire WD-1A/TT

3. Telephone cable WF-16/U. This cable has four copper cadmium alloy stranded insulated conductors in two pairs. One pair is olive drab; the other brown. (See Figure 1-3.) The olive drab conductor has a ridge along the side for night identification. These conductors have the following characteristics:

- Copper cadmium alloy stranded.
- Tensile strength of 200 pounds.
- Weight of 62 pounds per 1.6 kilometers (1 mile).
- Length of 1.6 kilometers (1 mile).
- Four-wire, telephone cable.

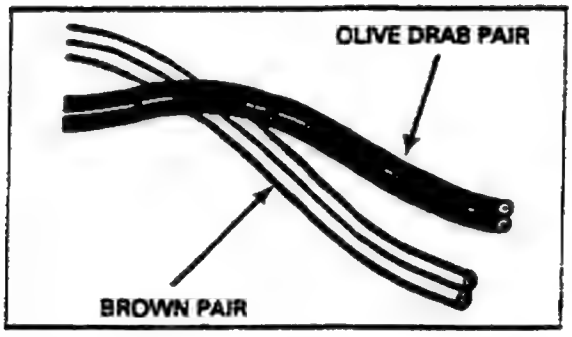


Figure 1-3. Field wire WF-16/U.

4. Field wire reels. The type of reels (see Figure 1-4) available for use with telephone cable (field wire) are identified below.

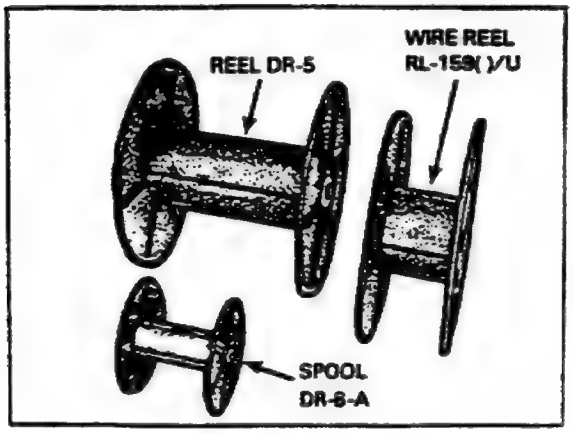


Figure 1-4. Reels for field wire.

a. Reel DR-5 is a metal spool-type container used to store, transport, lay, or recover field wire. It will hold four kilometers (2.5 miles) of field wire and can be mounted on reeling machine RL-207/G or reel unit RL-31( )/G.

b. Reel RL-159/U is a metal spool-type container used to store, transport, lay, or recover field wire. It will hold 1.6 kilometers (1 mile) of field wire and can be mounted on reeling machine RL-207/G or reel unit RL-31( )/G. The RL-159/U is the primary reel used for WD-1( )/TT.

c. Spool DR-8(A) is a metal container used to lay or recover field wire. It will hold .4 kilometer (1/4 mile) of field wire and can be mounted on reel unit RL-39( ) (component of reel equipment CE-11).

d. Wire dispenser MX-306( )/G is a cylindrical canvas and tape container that holds approximately .8 kilometer (1/2 mile) of wire WD-1( )/TT. The wire of two or more dispensers may be prespliced in tandem when it is necessary to lay a wire line of more than .8 kilometer (1/2 mile) without stopping to splice. (See Figure 1-5.)

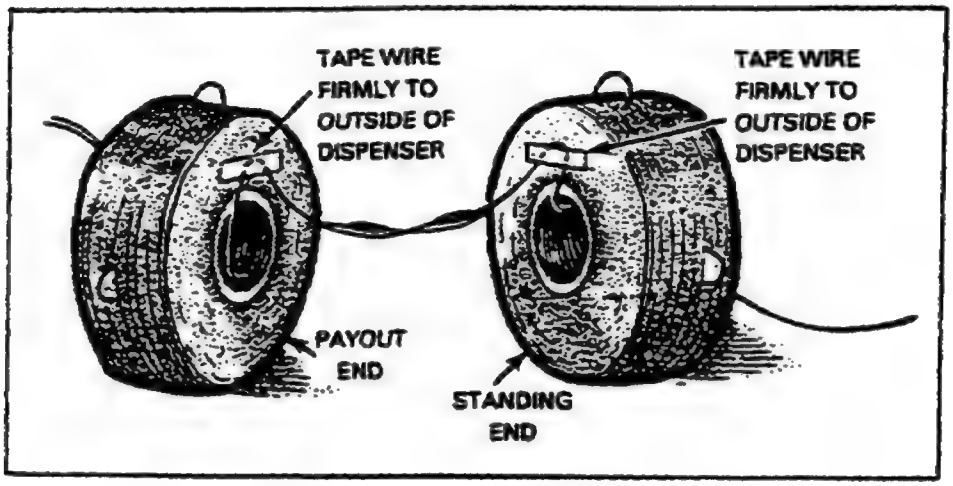


Figure 1-5. Wire dispensers MX-306/G, spliced for tandem operation.

5. Axle RL-27( ). Some of the units will have this piece of equipment which makes it easier for two people to install the telephone cable. It is used to lay and recover wire lines. The axle is a machined steel bar (2 1/2 feet long) used for mounting wire reels. The axle has two knurled handles, one removable for mounting wire reel RL-159/U on the axle. The axle has roller bearings and is equipped with a removable crank for rewinding wire. The axle can be carried by two individuals or placed on some improvised mounting. (See Figures 1-6 and 1-7.)

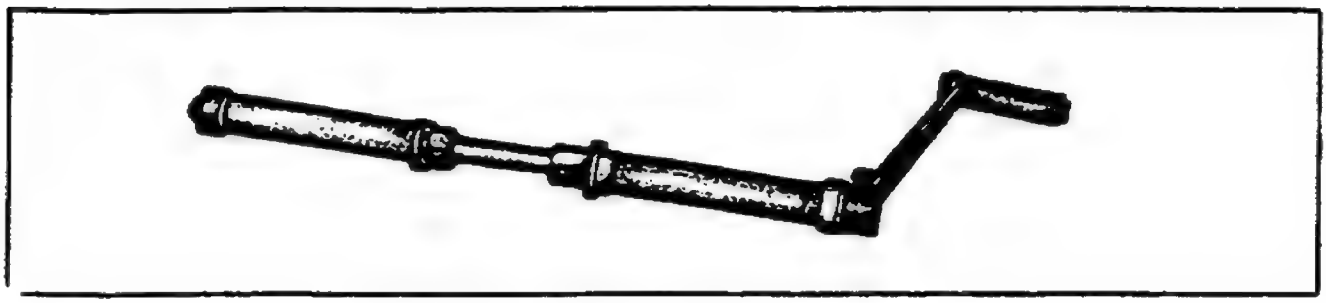

Figure 1-6. Axle RL-27(*).

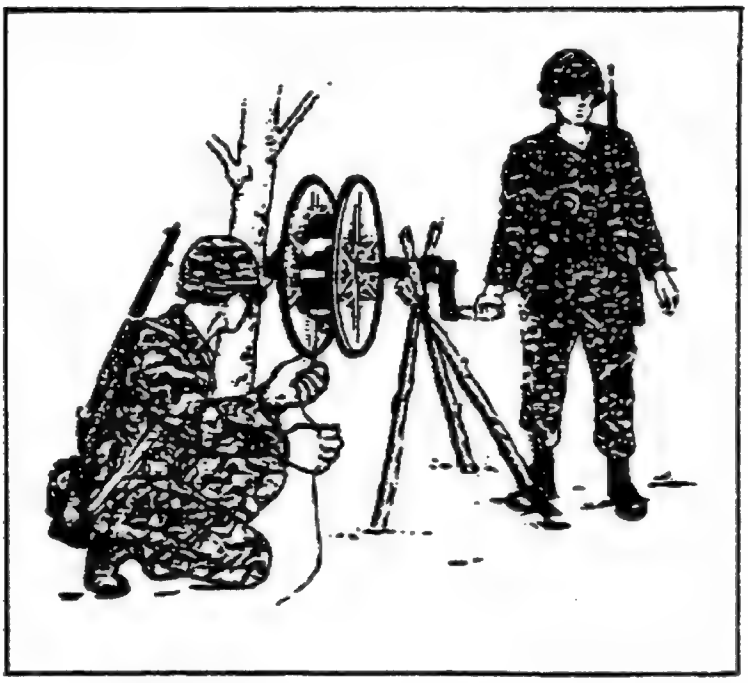

Figure 1-7. Method of recovering field wire,
using axle RL-27(*).

6. Reel unit RL-31( )/G is a lightweight, portable, folding A-frame of steel tubing used for paying out and recovering field wire and field cable. (See Figure 1-8.)

a. The reel unit features:

- Brake unit for controlling speed of reels during payout of wire.
- Crank for reeling in wire on reels.
- Carrying strap for carrying the reel unit litter style.
- Divided axle when two reels are mounted on the reel unit. This axle allows either reel to operate independently.

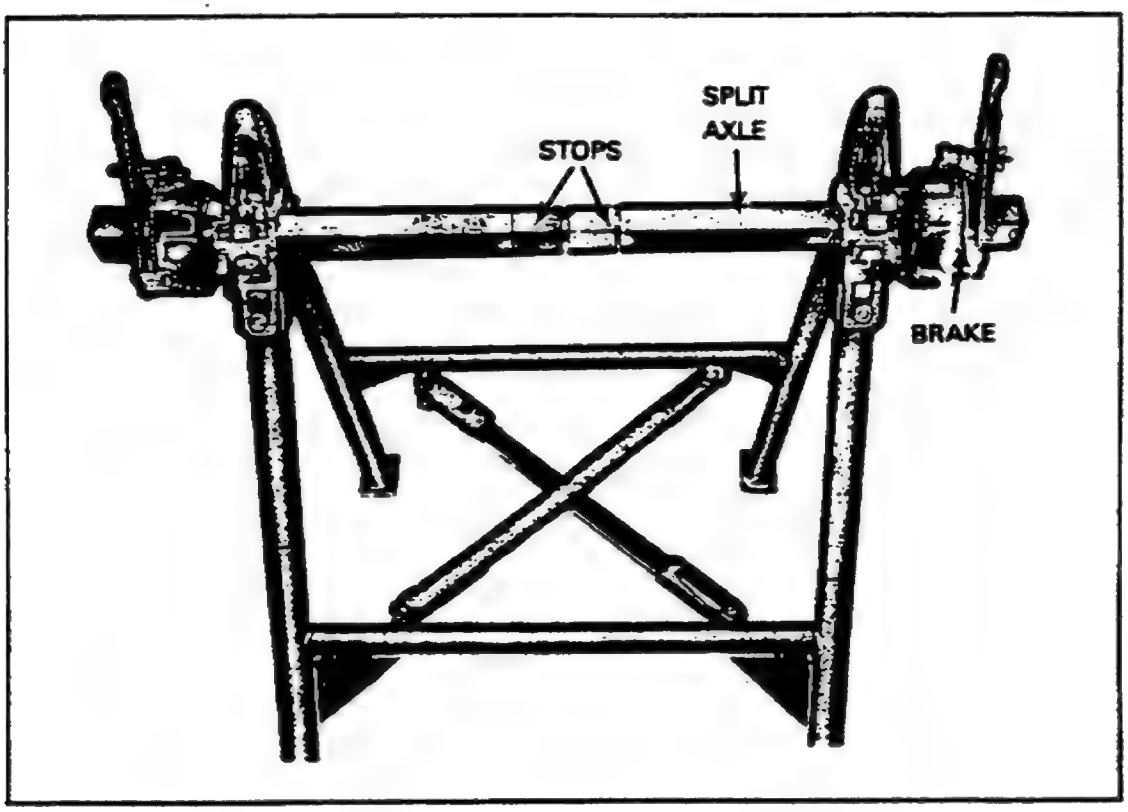


Figure 1-8. Reel unit RL-31( )

b. The reel unit can carry a single reel DR-5 or DR-15B, or two wire reels RL-159/U.

c. Reel unit RL-31( )/G can be mounted on the ground or on a vehicle. A special vehicular installation kit is available.

d. For more information, see TM 11-3895-202-13.

7. Tool equipment TE-33 is used for making field wire splices. It consists of pouch CS-34, pliers TL-13A, and electricians knife TL-29. (See Figure 1-9.) These items should be available in the unit or through the Self-Service Supply Center.

8. Electrical or friction tape. Two types of insulating tape may be used in making field wire splices—electrical insulation tape TL-636/U (black polyethylene), used in tropical and temperate zones and electrical insulation tape TL-600/U (white polyethylene), used in the arctic and during cold weather in temperate zones. Tape TL-83 (friction) may be used for added protection of the splice.

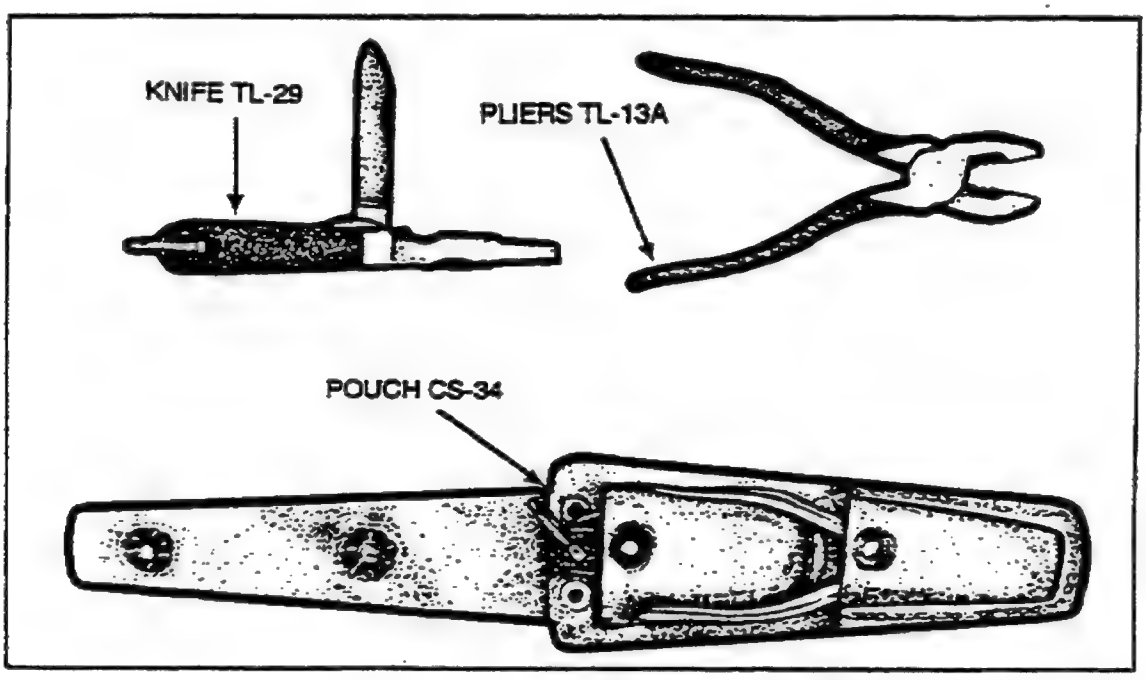


Figure 1-9. Tool equipment TE-33.

9. Tool equipment TE-21. Climbing equipment is used by wiremen to climb poles or trees without pole steps or ladders. It permits the wireman's hands freedom for performing work while aloft. (See Figure 1-10a.)

a. Climbers LC-240/U are adjustable lightweight, metal climbers. The length can be adjusted from 14 3/4 to 19 1/2 inches for different leg sizes. (See Figure 1-10b.)

b. To sharpen the gaffs, gaff gage TL-144 is available to check the gaffs of climbers LC-240/U. (See Figure 1-11.)

10. Lance poles PO-2 provides a convenient method of supporting aerial lines. These wooden poles, which are 14 feet long and 2 inches in diameter, are tapered from the bottom to top with a sharpened or conical point at the bottom. (See Figure 1-12.) An insulator pin is attached to the top of the pole. Two poles can be lashed together to provide the proper height when crossing a primary or secondary road. Normally, the minimum span for using lance poles is 100 feet. They can be strengthened by using two on the bottom and one on top.

11. Linesman bag. This is a bag with a leather bottom to carry all the small items needed to do the construction work (See Figure 1-13.) You can carry the hammer, marline cord, tags, grease pencil, stakes, and other small items that you will need.

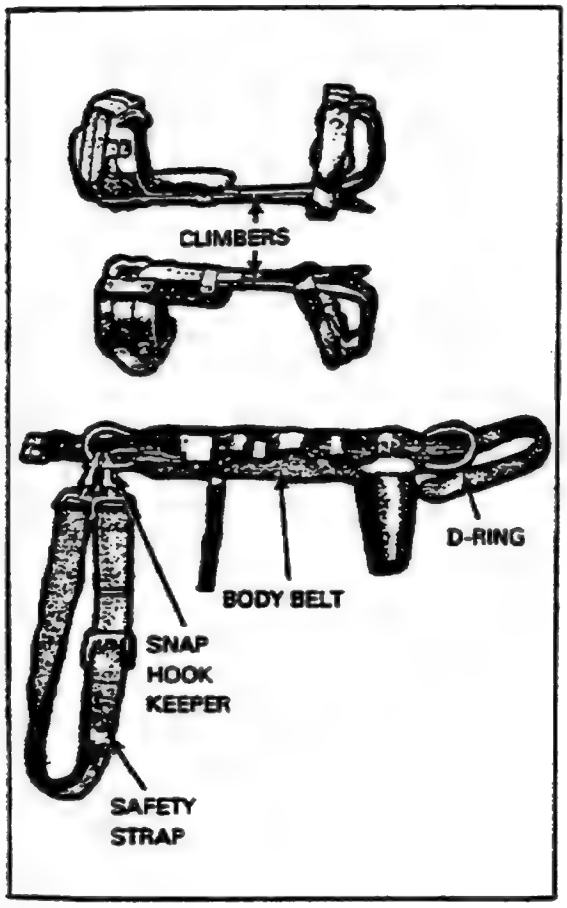


Figure 1-10a. Climbing equipment.

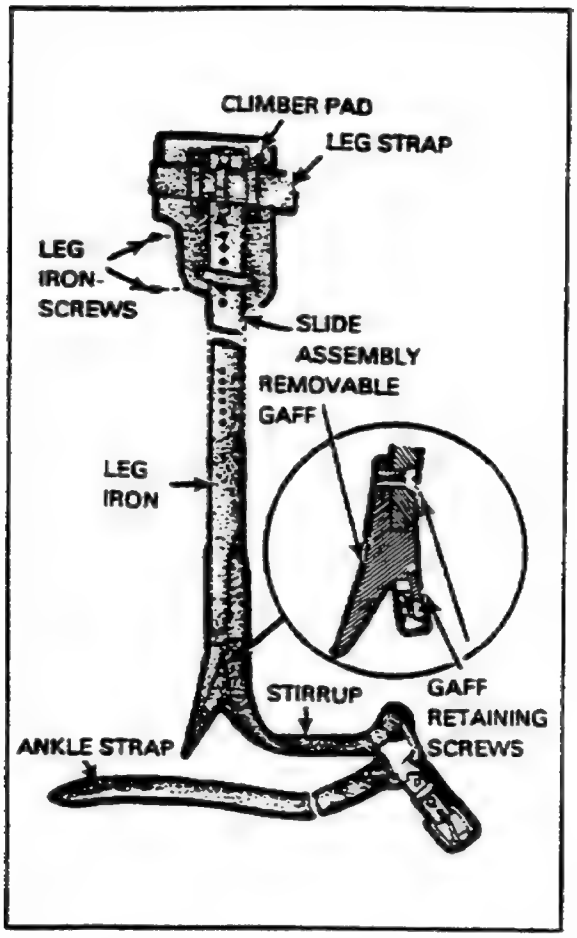


Figure 1-10b. Climbers LC-240/U.

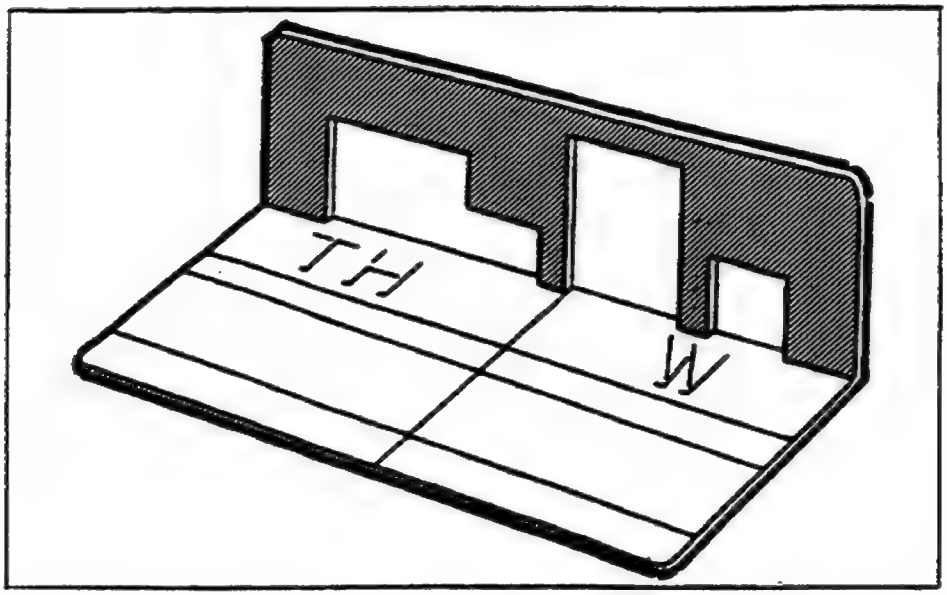


Figure 1-11. Gaff gage.

Figure 1-12. Lance poles PO-2.

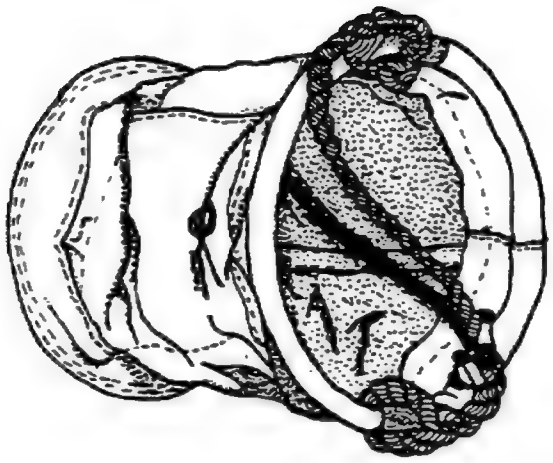

Figure 1-13. Linesman bag.

12. Tags are important for circuit marking. You do not install a wire line without identifying the line. All wire lines must be identified per the local signal operating instructions (SOI).

a. Circuits are designed by individual circuit numbers, switchboard designators, or a combination of the two. Field wire lines are numbered consecutively and no two lines are given the same number.

b. Tagging of field wire lines is necessary because tags often provide the only method of distinguishing one line from another. Tagging simplifies the turning over of wire systems to relieving units, makes line tracing easier, and simplifies maintenance. If tags, normally issued as a field item, are not available, a unit is expected to improvise substitute tags. Every unit is responsible for ensuring that its lines are adequately labeled.

c. Placement of tags will be discussed later. Some examples of tags and how they are identified are shown in Figure 1-14.

13. Telephone set TA-312/PT is a small, rugged, waterproof, portable field telephone that was designed primarily for operation in the field on a local battery system. (See Figure 1-15.) However, the telephone will also operate on a common battery system and common battery signaling system.

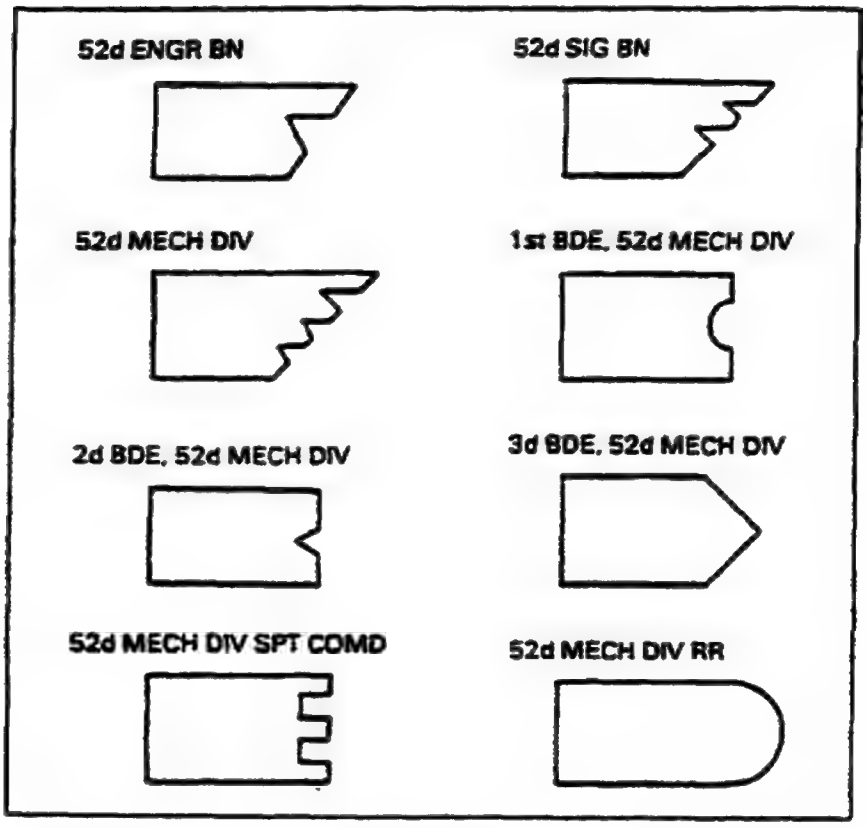
52d ENGR BN
52d SIG BN
52d MECH DIV
1st BDE, 52d MECH DIV
2d BDE, 52d MECH DIV
3d BDE, 52d MECH DIV
52d MECH DIV SPT COMD
52d MECH DIV RR

Figure 1-14. Wire tagging code.

a. The telephone is no longer limited to use with manual switchboards. It can be attached to a tone signaling adapter TA-955/PT which turns the telephone into a pushbutton, dial tone, two-wire, common battery subset capable of producing the standard dual tone signals used by military and commercial automatic switching systems. (Don't forget the batteries, BA-30 or BA-3030.)

b. For additional information, see TM 11-5805-201-12.

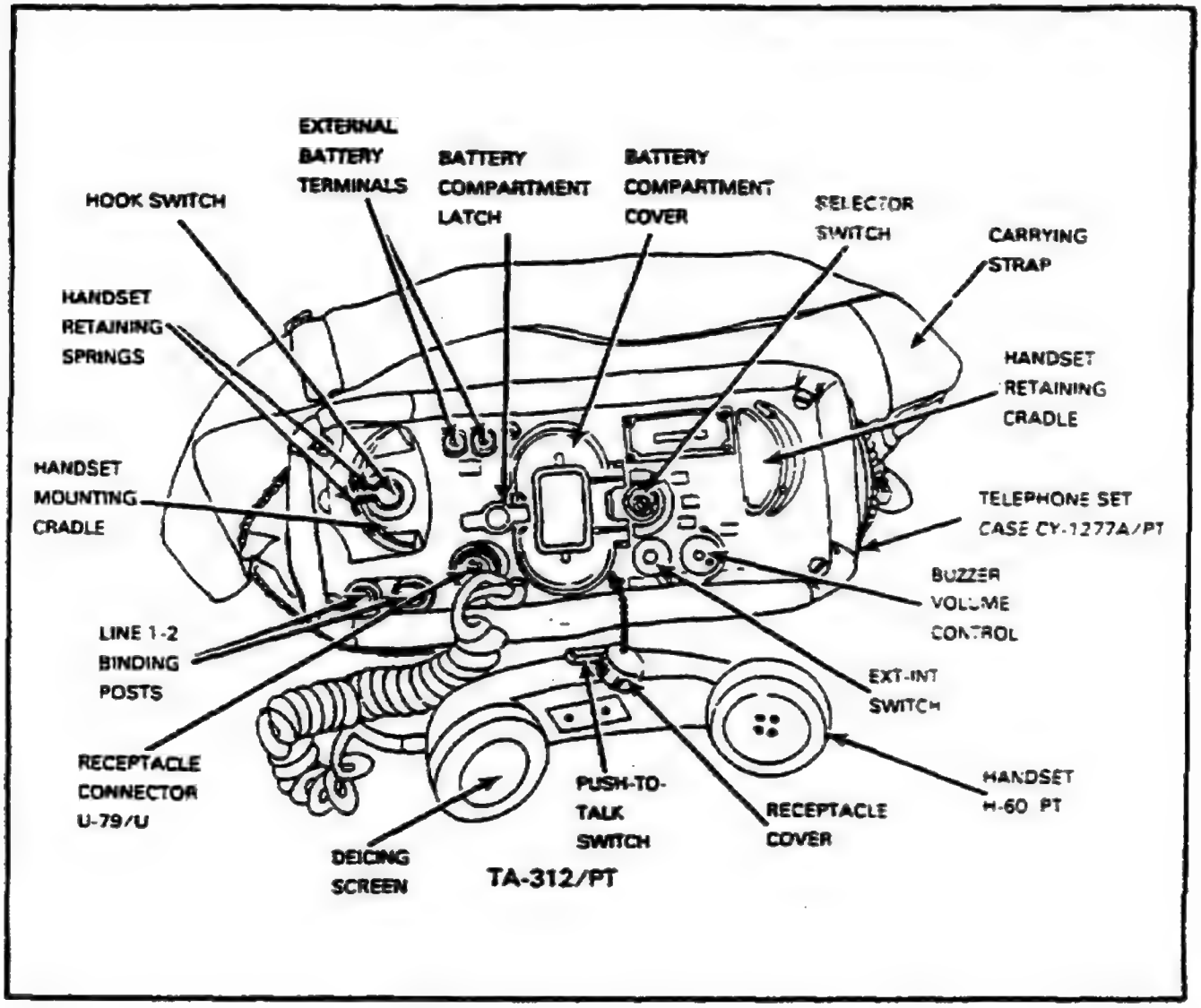


Figure 1-15. Telephone set TA-312/PT.

14. There are some other items that you will need for the installation of telephone cable WD-1( )/TT or WF-16/U.

a. Ensure you have the following:

- Gloves to protect your hands.
- Marline cord to tie the lance poles together and to secure the wire when needed. (See Figure 1-16a.)
- A hammer, two-pound size, used to drive wooden stakes in the ground. (See Figure 1-16b.)
- Eye protection is needed since splinters may come off the stake. (See Figure 1-16c.)
- A shovel, preferably the D-handle shovel you have on your vehicle. (See Figure 1-16d.)

b. A lot of equipment is needed to install a telephone line. Remember that you are installing a telephone line from scratch. You will be installing either a point-to-point line or a line from a switch which would provide service similar to that you have at home.

c. When you go on the job, it is best to check and be sure you have all your tools since time is wasted when you have to return to pick up the smallest item.

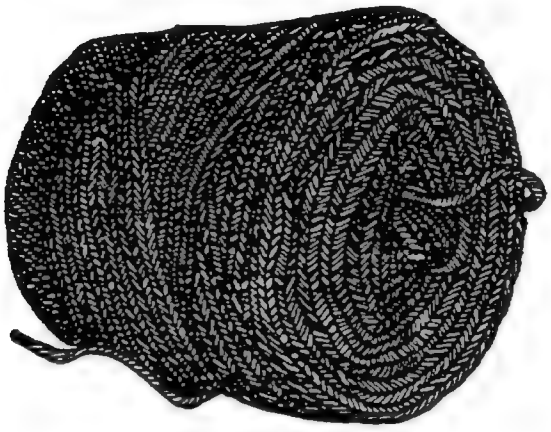

Figure 1-16a. Marlin cord.

Figure 1-16b. Hammer.

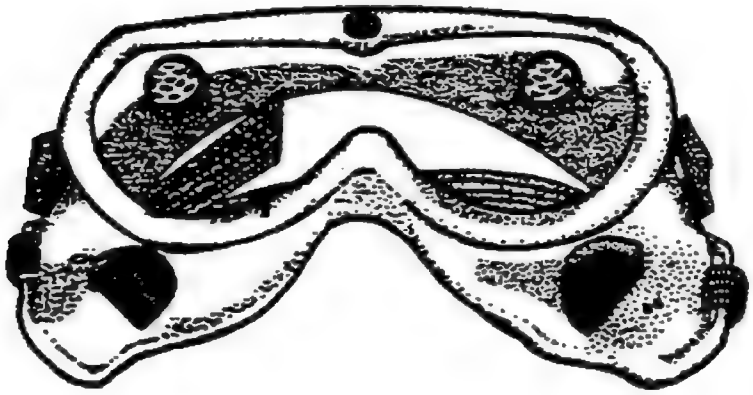

Figure 1-16c. Eye protection.

Figure 1-16d. Shovel.

## PART C - THE INSTALLATION

1. Now that you are familiar with safety and the equipment needed to do the job, it is time to discuss how a telephone line is installed. It is not something you would just go out on your own and do without learning the proper techniques.

2. Some lines are short and within the node. These are usually installed first because this is where the staff elements for command and control are normally located. Before a telephone line can be installed, you must know the location, type of service required, and priority of installation. This information will have been given to your team chief/supervisor. You would get your instructions from him and begin installation.

3. Are you going to start at the switch or are you installing a point-to-point line? For this lesson, the discussion will be about installing a point-to-point telephone. Installation will be from one tree or post to another. All the work will be outside. Now that you know what needs to be done, start with the procedures for installing the first instrument on the line.

a. The telephone set TA-312/PT is a universal telephone. It is used on many guard posts or point-to-point lines and WD-1( )/TT can be used to install the line. A tree or tall post should be selected and the telephone installed in a vertical position. Use the strap on the case to wrap around the pole above the telephone to keep it from slipping down. You will need a piece of WD-1( )/TT to go around the pole at the bottom of the telephone to keep it from flopping around. Be sure the wire goes through the lower loop of the carrying case and tie it securely in place.

b. Now check the selector switch and see that it is set on LB. This is because you will install two BA-30 or BA-3030s in the battery compartment to provide talk power. Remember, this telephone has a crank on it to ring the distant end. Since the handset is off the telephone, check to see if the de-icing screen has been installed. It is only used to keep the operators breath from freezing on the transmitter.

c. If the de-icing screen is not required or installed, you must make the adjustment to the telephone. To install or remove the de-icing screen, unscrew the transmitter cap and look into the cap. You can use a screwdriver to pry it out gently or you can install one in the cap.

d. Some units use the off-hook lamp assembly for security reasons. If you have to install one it is quite simple. Remove the panel screw nearest to the LINE binding posts. Secure the lamp to the telephone with this screw, keeping the lamp snuggled near the telephone cradle. Run the lead of the lamp assembly around the retaining brackets and connect its two terminals to the BAT binding post on the panel.

e. You must check the WD-1( )/TT you are going to use. Connect a telephone to each end, ring it down, and talk on the line. This is the best check you can make.

f. It is time to connect the WD-1( )/TT. Strip approximately 1 inch of insulation from the ends of the two wires in the line to be connected. Be sure the wire is clean and there is no residue remaining. The unit SOP will state whether to keep some insulation on the end of the wire. If not, fold back the stripped wires about 1/2 inch from the end. Push down one of the LINE 1-2 binding posts. Insert the bare end of one wire into the binding post slot and release the post. Check to see that the wire is securely clamped. Repeat the procedure with the other wire, in the other post. Install a tag on the telephone D-ring and mark it according to your unit SOI to identify the circuit.

4. Check your work. The telephone is installed, batteries are installed, the selector switch is set to LB position, de-icing screen is installed, security lamp if needed, and you are connected to the line. Did you take into consideration what happens to the wire now?

Remember, the telephone is installed on a pole, so to keep the wire from being pulled loose you should have secured the line first. Disconnect the line. Secure the line to the lower D-ring of the case with a half knot. Pass the wire through the opening of the case and telephone to the binding posts. Did you make sure it was under the strap holding the telephone in the case? If so, secure the line to the LINE 1-2 posts again. Now where is the line going? Will it be aerial or will it lay on the ground? It will be aerial to begin with. Why? Remember, you are in a NODE area and there will be foot and vehicular traffic so the line must be protected.

5. If you have access to the equipment, you may want to practice installing the telephone on a post or pole at this time to be sure you can do it. Perform this procedure as shown in Figure 1-17.

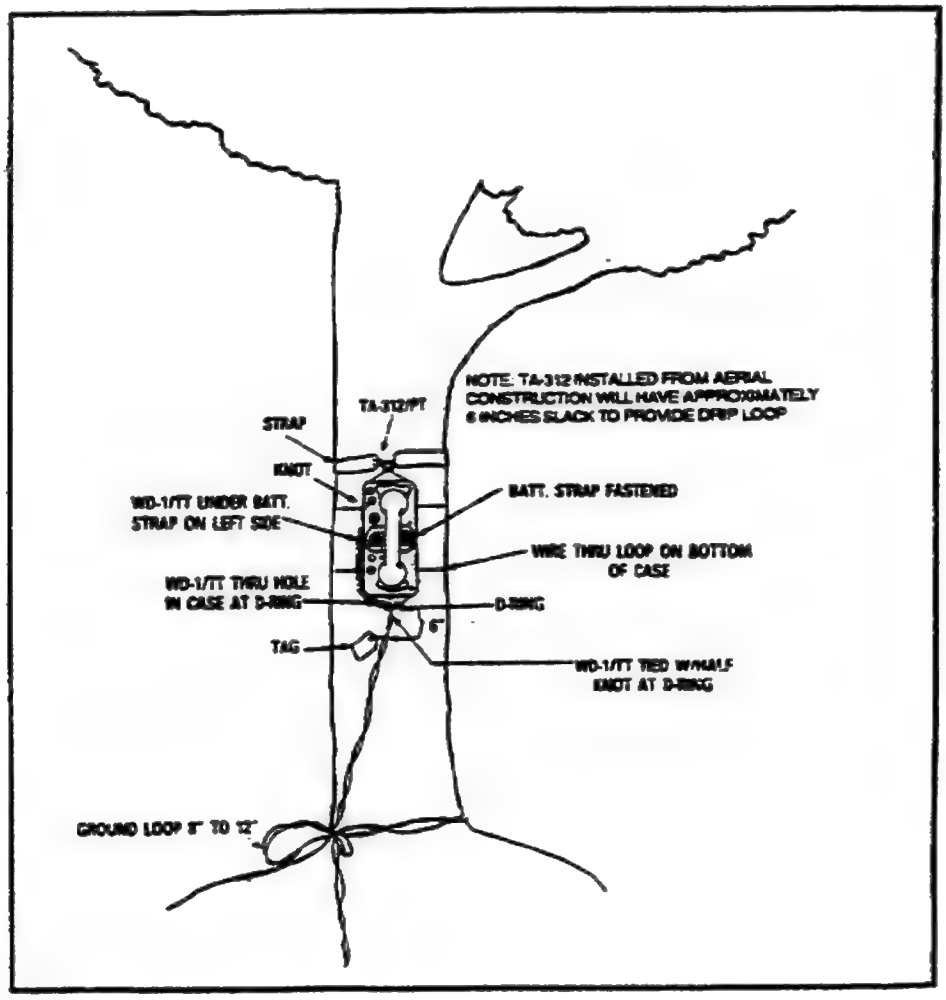
NOTE: TA-312 INSTALLED FROM AERIAL CONSTRUCTION WILL HAVE APPROXIMATELY 6 INCHES SLACK TO PROVIDE DRIP LOOP
TA-312/PT
STRAP
KNOT
WD-1/TT UNDER BATT. STRAP ON LEFT SIDE
BATT. STRAP FASTENED
WIRE THRU LOOP ON BOTTOM OF CASE
WD-1/TT THRU HOLE IN CASE AT D-RING
D-RING
6"
TAG
WD-1/TT TIED W/HALF KNOT AT D-RING
GROUND LOOP 8" TO 12"

Figure 1-17. TA-312/PT installation.

6. How did you do? If you had some problems, you should review the material.

7. As discussed, aerial installation will be used first. Before the line is brought to a point where it will be secured, check the line at the telephone and make sure there is a 6-inch drip loop under the telephone. This permits the water, when it rains, to run down the line and drip off the wire rather than running to the telephone and causing trouble on the line.

a. Because the installation is in a NODE, you want to consider secondary roads. A minimum height clearance of 14 feet is necessary for secondary roads. Primary roads require a height clearance of 18 feet. When the desired height is reached, an aerial loop-knot tie will be used. Refer to graphic training aid (GTA) 11-1-13 for the aerial loop-knot tie.

b. At this time, if equipment is available, practice the aerial loop-knot tie with a 12-foot piece of WD-1( )TT. When you are confident you can make the tie, proceed with the lesson.

c. Take the line up to the desired height and tie an aerial loop-knot tie. Go to the next pole or post and continue the installation with an aerial loop-knot tie. When the end of the aerial installation is reached you will have to bring the line back down to the surface mode of construction. At the surface, and no higher than 3 to 6 inches off the ground, tie a ground loop-knot tie. Refer to GTA 11-1-4, ground loop-knot tie. Leave enough slack for repair should the line be broken.

d. If it is available, take that same 12-foot piece of WD-1( )/TT and practice tying a ground loop-knot tie until you can do it correctly.

e. If you are practicing ties, practice the clove hitch tie. Refer to GTA 11-1-2, clove hitch tie. Practice that tie until you can do it correctly.

f. Remember to tag the line when you change construction from aerial to surface. You must remember that whenever you change construction-surface to aerial, aerial to surface, surface to buried, and buried back to surface-you must tag the line and properly identify the circuit. When a line is run beside another line and there is a possibility of confusion later on, you can tag at several points to help you identify that circuit. Tagging is important. You will find that out when it is time to troubleshoot the line turn the line over to another unit that is relieving your unit, or when it is time to recover the line. On poles, tag the line 6 inches up from the knot.

g. Another important area to discuss at this time is sag. When wire lines are tied in an aerial condition you must provide for the weather, heat, cold, and the wind to have an effect on the lines. There must be some sag in the line so it does not break when it gets cold or when the wind blows excessively. To allow for sag in the line, you must know the distance between the two aerial ties. Provide 6 inches of sag for every 25 feet of line. If the line is stretched 100 feet between ties you would have to provide for 24 inches of sag in the middle of the line. How did you get 24 inches? Divide the length 100 by 25 inches equals 4 and then multiply that by the 6 inches and you get the 24 inches of sag needed on that particular line. Check the line to be sure there is the right amount of sag in the line.

h. If telephone or power poles are used, there is another important item to remember. Never tie telephone lines WD-1( )/TT or WF-16/U closer than 4 feet to a power line. The general rule is 4 to 6 feet below the power line. This protects the installer, keeps him off the line, and in general provides working space for other construction crews.

**CAUTION**

**All electric light and power wires must be considered to be carrying dangerous voltage. Do not tie field wire lines to transformer cases, electric light brackets, or power crossarms. Be extremely careful when working near power lines. Observe all safety precautions and follow safe construction practices.**

8. It is important to remember all the information provided as construction of the line continues. Surface construction begins at this point. In surface construction, the line is laid loosely, with plenty of well distributed slack (approximately 20 percent) along the line. Slack allows the line to lay flat and simplifies maintenance and construction changes.

a. Surface lines should be secured as you go along. They can be tied to trees or posts to prevent passing troops from pulling the cable into traffic lanes. All ties should be made at ground level with a ground loop-knot tie. Surface lines must be kept off roads and road shoulders. The principle advantages of surface lines are that less time and fewer personnel are required for installation, and, when laid loosely, surface lines are less vulnerable to artillery fire.

b. The main disadvantages are that surface lines may become unserviceable in wet weather and may often be broken by passing troops and vehicles.

c. When surface lines are laid along a road, keep the wires well off the traffic lanes. However, installation is not complete until a thorough policing of each circuit has been completed.

d. If equipment is available and you feel you may have a problem doing surface construction, go and practice. It is better to make mistakes in practice where you can learn and correct the error than to make the mistakes during the construction.

9. At some point it will be necessary to cross a road. You will use the lance poles PO-2 we discussed earlier. They provide a convenient method of supporting aerial lines. These wooden poles are ideal to get wire lines across a road.

a. A wire line crossing a road must have the proper clearance. Remember, it is 14 feet for a secondary and 18 feet for a primary road. To attain this height, you have to lash two poles together. When additional strength is required, two lance poles are lashed together at the base. Lash the poles with field wire or marline cord, overlapping the poles at least 5 feet. This type of construction can support up to 10 field wire lines for short spans such as road crossings.

b. An aerial span supported by lance poles must be securely guyed. To erect and guy an aerial span, proceed as follows:

(1) Lash the lance poles together (see Figure 1-18) and lay the poles on the ground parallel to the road.

(2) Tie the wire line to the insulator on the lance pole (use clove hitch tie). Use a 4-6-inch piece of tape to secure the wire to the insulator.

(3) Tie one end of each guy wire near the top of the lance pole. (Field wire is suitable for guy wires or marline cord may be used.)

(4) Raise the lance poles and line into position.

(5) Tie the guy wires at a 45-degree angle from the line to a secure object such as a post, tree, or stake at a one to one ratio. That means for every 1 foot of height, you move the stake back from the lance pole 1 foot at a 45-degree angle.

(6) Tie the wire line to a stake at the bottom of the lance pole.

(7) Tag the line approximately 6 inches behind the stake away from the road. You don't want to lose the tag if you lose the wire because something happened to your lance poles. Leave enough slack for reconstruction.

(8) See Figure 1-19 for a properly constructed aerial span.

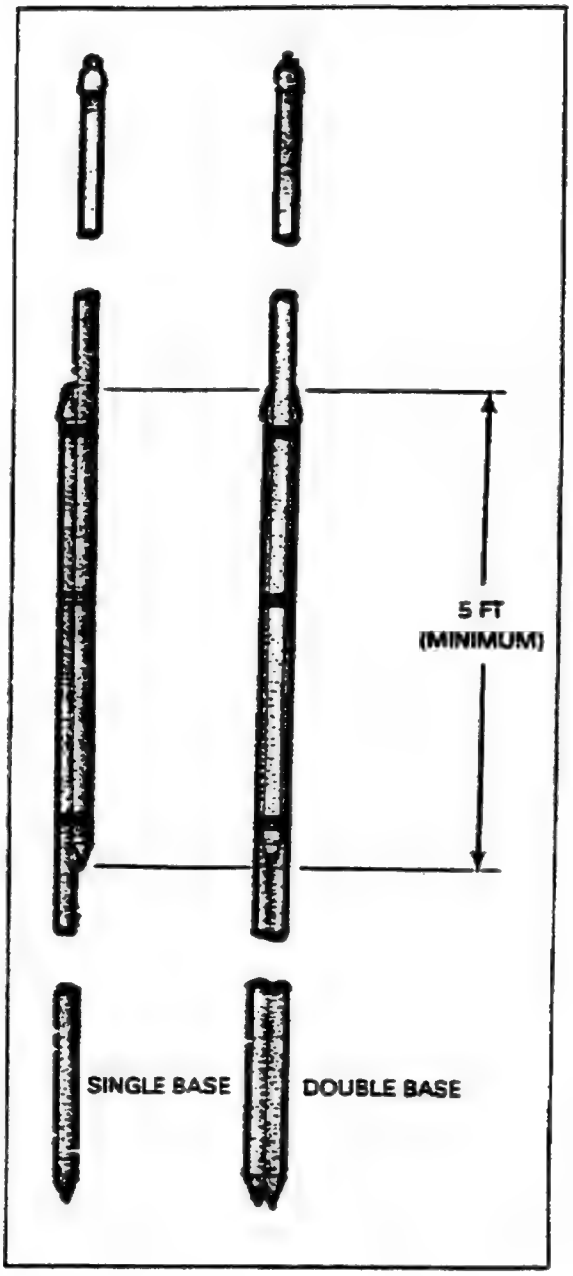


Figure 1-18. Lashing lance poles.

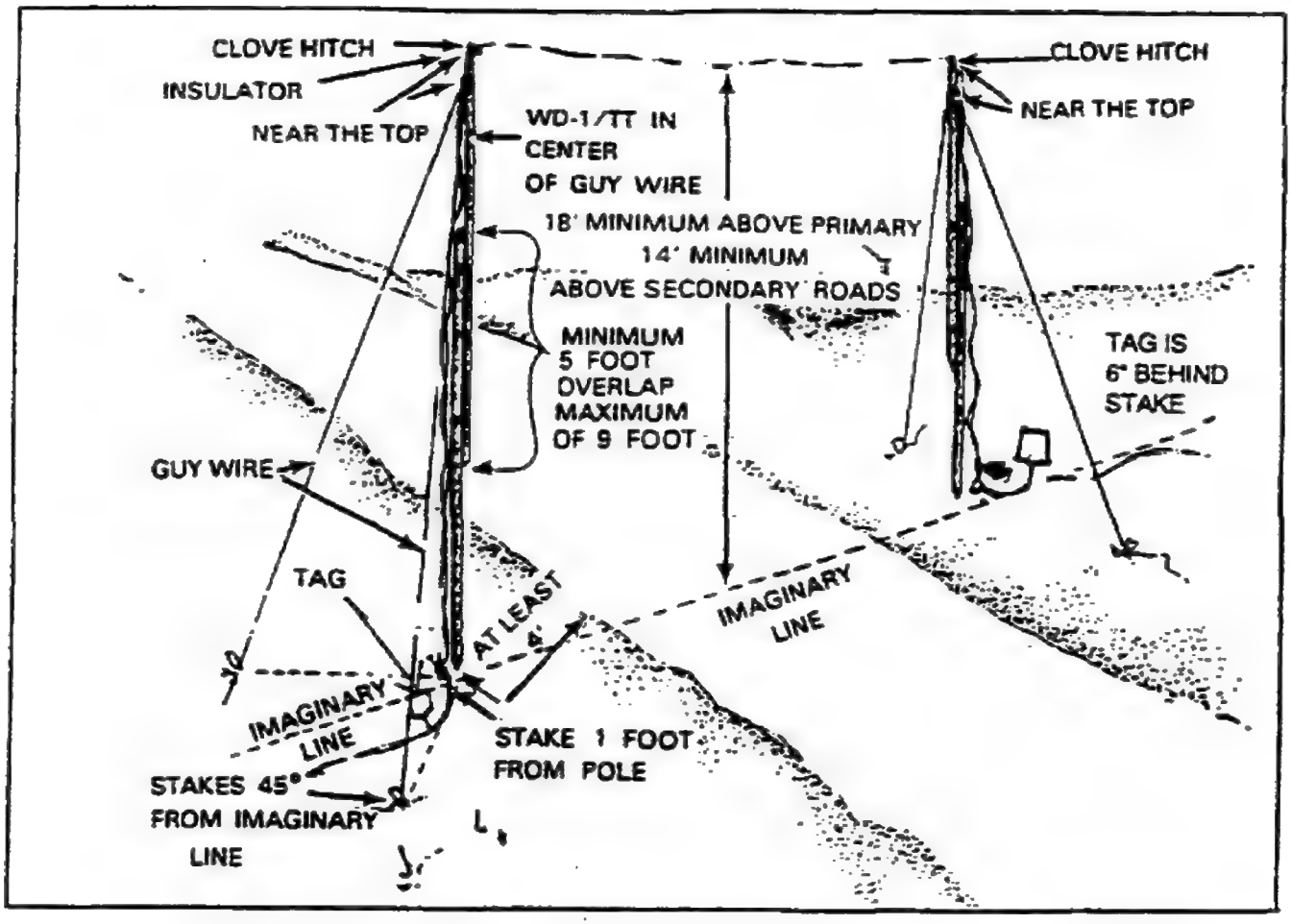


Figure 1-19. Wire construction across roads, using lance poles.

c. Lance poles used to support aerial field wire lines must be guyed at each pole. Each pole has two guys at right angles to the direction of the line. Each tenth pole is four-wire guyed, with two guys on each side of the line at a 45-degree angle from the line at the one to one ratio. The length of each span will vary according to the storm loading in that particular area. The normal span is 100 feet.

d. Other methods of crossing a road. This can be done by placing the lines through a culvert, installing aerial lines, or burying the lines. For hard surfaced roads that are subject to wheeled vehicle traffic and do not permit burial, the wire may be laddered. This is done by cutting the field wire and by splicing one or more lengths of twisted pair to each conductor. These lines are then laid across the road in parallel paths at distances greater than the longest vehicle expected to use the road. The ends of the laddered arrangement are spliced to the original conductor on the other side of the road in the identical manner. When properly staked, these laddered lines (each rung serving as a single conductor) will provide initial communication, but should be replaced by an aerial crossing when the line is policed.

(1) Placing wire lines through culverts is the fastest method of getting wire lines from one side of the road to the other. The wires are passed through the culvert, and are tied with a clove hitch and tagged at each end of the culvert with two clove bitches. Stakes will be placed at an angle so that when the wire line is tied to the stakes, the line is tight and near the top of the culvert to protect it from water and debris. (See Figure 1-20.) Where the wire comes in contact with the culvert, the wires will be wrapped with friction tape to prevent damage to the insulation. Leave 100 percent slack for reconstruction.

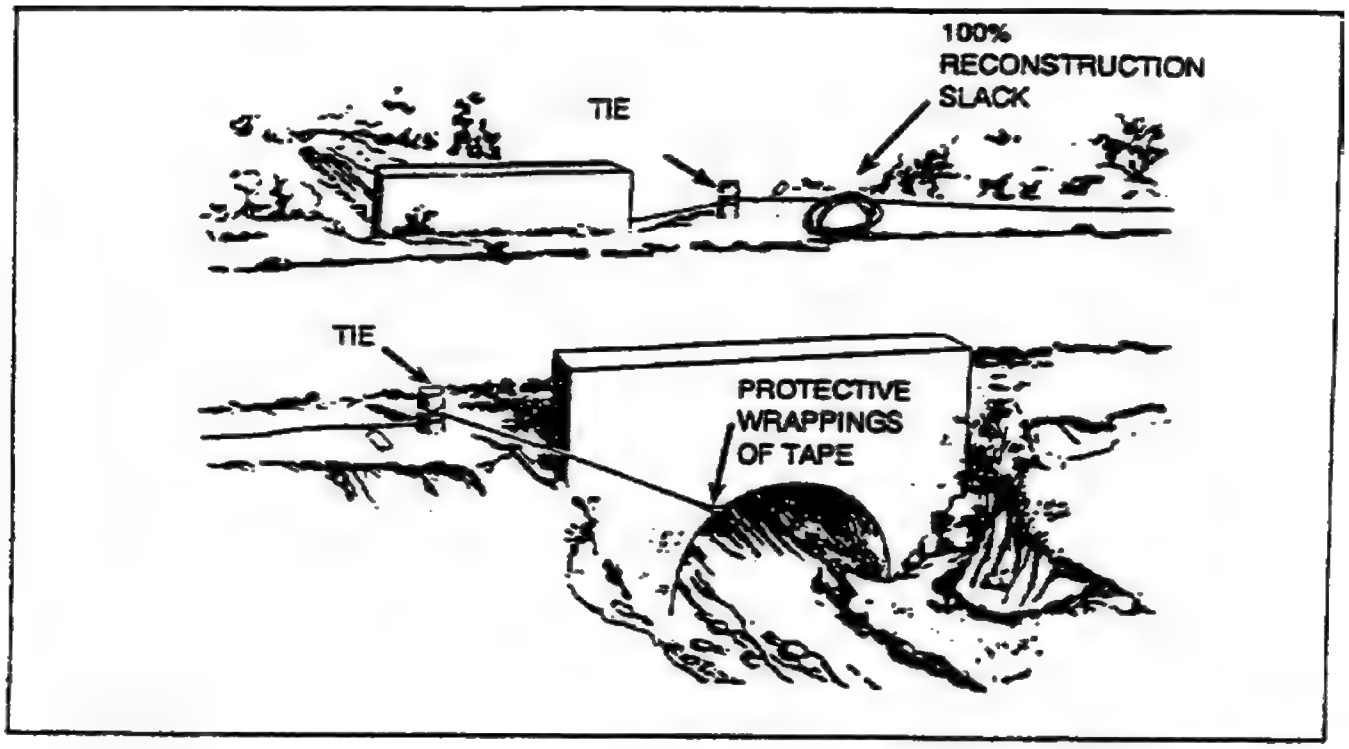


Figure 1-20. Wire crossing through culvert.

(2) At this time, if equipment is available, go out in the training area and practice the culvert crossing. Have your supervisor check your work. If you have any problems, go back to the text.

e. Another method of getting across the road is to bury the line. (See Figure 1-21.)

(1) If you are crossing a hard packed dirt road dig a trench 6 to 12 inches deep across the road. If you are crossing a sandy road with loose sand, you must make the trench three feet deep. The trench should extend at least 2 feet beyond each side of the road.

(2) Lay the wire loosely in the trench and place a stake 1 foot from where the wire comes out of the ground. Tie the wire to the stake using a clove hitch. Tag the line approximately 6 inches from the stake on the field side.

(3) Backfill the trench. Do not place stones or sharp object on the wire. These objects could crush the wire insulation when passing vehicles cross over the trench. Try not to leave a high bump or small trench when you backfill.

(4) Leave enough slack on the running end of the wire, rolled up and taped, to permit replacement of the wire in the trench. The running end is the direction you are going. Another useful technique for wire replacement is to place a spare wire in the trench with the working pair. This spare line should be tagged and tied to stakes with sufficient slack for splicing.

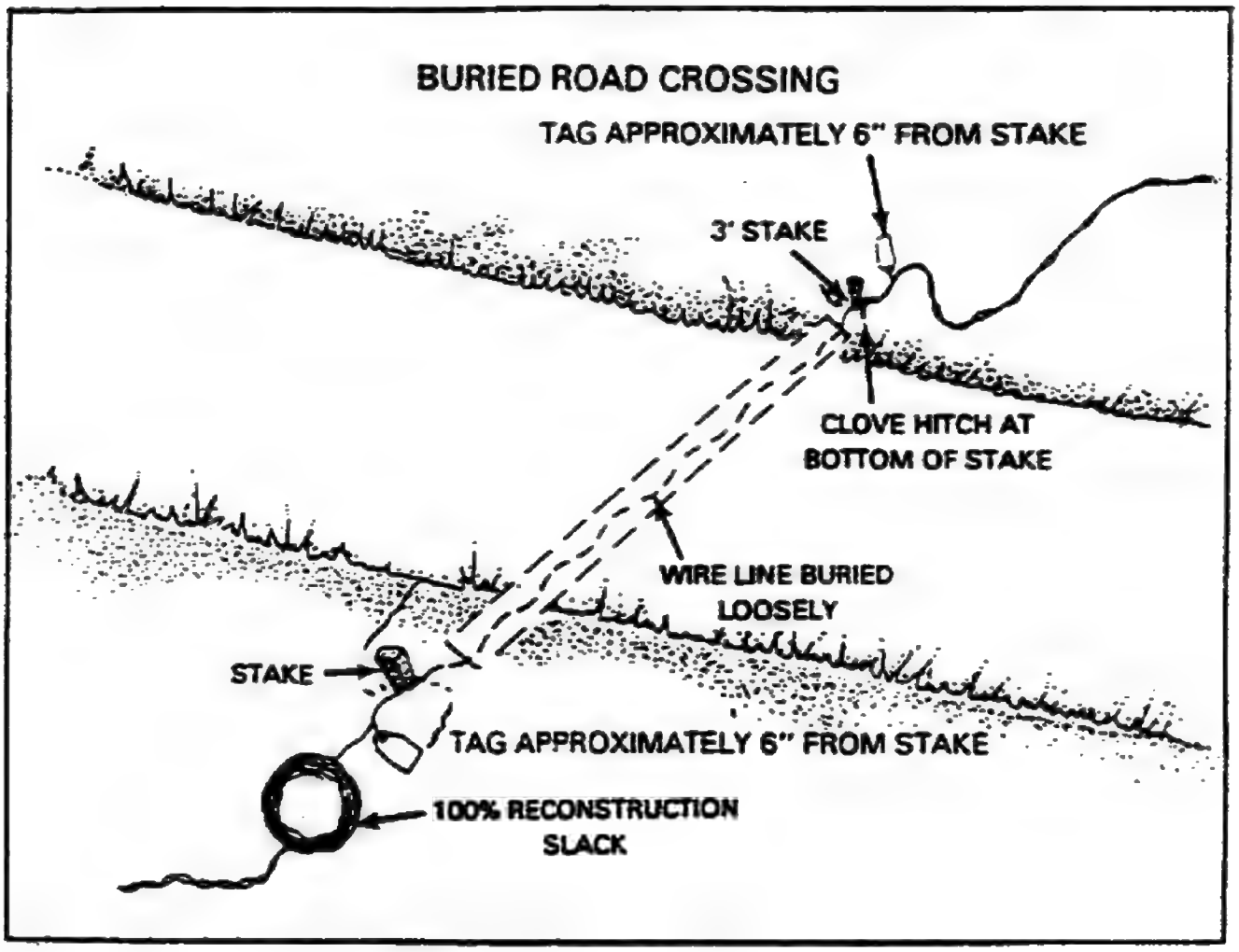


Figure 1-21. Wire buried in a trench to cross road.

10. Crossing a railroad. When field wire lines must cross railroad tracks, great care must be exercised in selecting the crossing site. If possible, the lines should cross underneath through culverts or aerially on bridges or via ducts. If none of these are available, lay the wires under the rails as shown in Figure 1-22.

a. To accomplish the railroad crossing—

(1) Pull sufficient slack from the wire reel to reach across the railroad track.

(2) Cut the wire at the reel and pull the end of the line under the rails of the track.

(3) Bury the wire lines from the rails to a point outside the shoulders of the track.

(4) Tie the line at the far end to a stake. Pull the line tight and tie it to another stake. Use clove hitches.

(5) Splice the free end to the end of the wire on the reel. Place tags approximately 6 inches from the stake on both sides of the railroad tracks. Leave 100 percent slack for reconstruction.

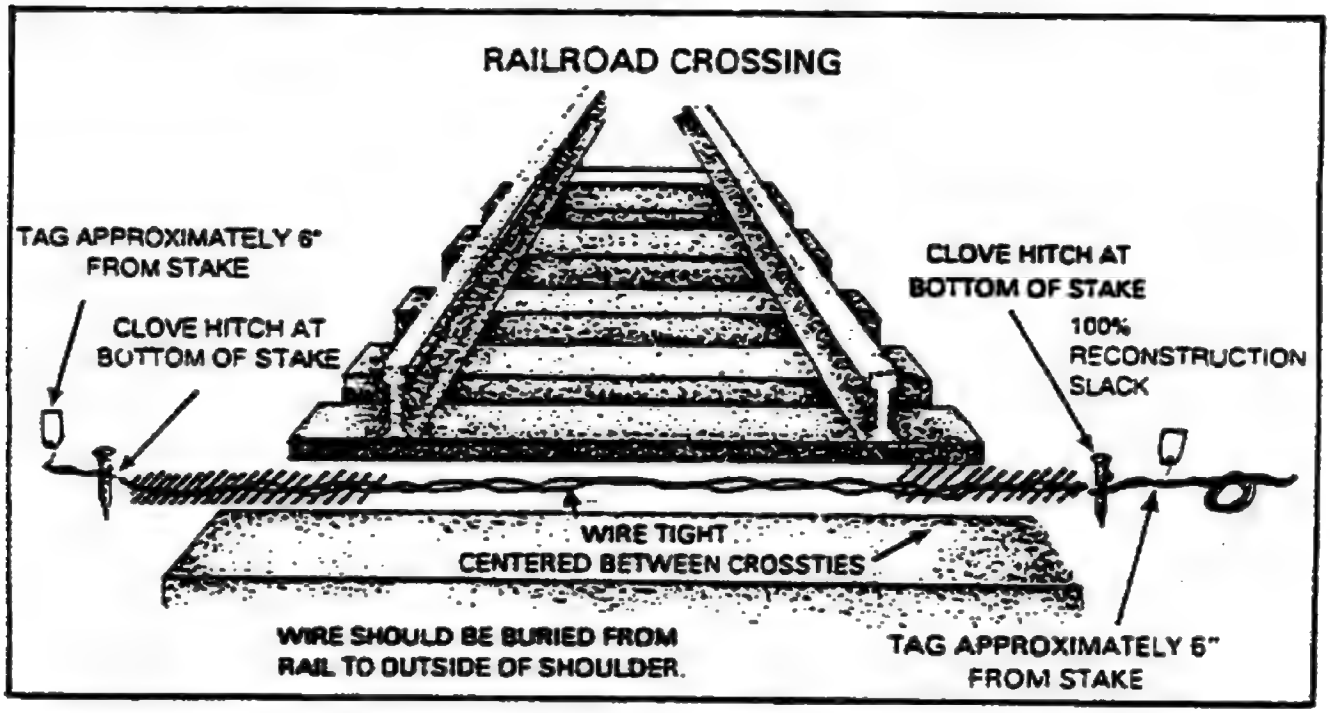
RAILROAD CROSSING
TAG APPROXIMATELY 6" FROM STAKE
CLOVE HITCH AT BOTTOM OF STAKE
CLOVE HITCH AT BOTTOM OF STAKE
100% RECONSTRUCTION SLACK
WIRE TIGHT CENTERED BETWEEN CROSSTIES
WIRE SHOULD BE BURIED FROM RAIL TO OUTSIDE OF SHOULDER.
TAG APPROXIMATELY 6" FROM STAKE

Figure 1-22. Wire crossing under railroad tracks.

b. If there is a nearby railroad on base that is not used very often perhaps you could go there and practice on the railroad crossing. Have your supervisor or team chief check your work. If you have problems, reread the material.

11. Constructing field wire lines under unusual conditions.

a. Terrain and climatic conditions will affect speed and types of construction used in installing field wire lines. Speed of installation, however, should not restrict good construction practices. Some areas that need emphasis are:

(1) Wire lines should be tagged more often for identification during maintenance.

(2) Test stations should be installed to facilitate maintenance.

(3) Wire lines should be suitable for the climatic conditions and to the type of construction. Wire ties should be made carefully to hold the wire lines in place.

b. The construction and maintenance of field wire lines in mountainous terrain is usually more difficult than in other areas. The lack of roads may make it necessary to lay wire lines by aircraft or by manpack wire laying equipment.

(1) When air-laying field wire in mountains, it is advantageous to lay the wire on top of trees and shrubs where possible and away from roads and trails to protect the lines from damage caused by traffic or rock slides.

(2) An air reconnaissance of the area should be made to determine route and areas to be avoided. If the lines are to be laid on the ground, it will be necessary to establish resupply points along the route. Supplies may be air dropped to speed the work.

c. In the arctic, there are additional problem areas of concern.

(1) The crew will need a heated shelter mounted on an M-35A2 or track vehicle.

(2) Tie three lance poles together at the top to form a tripod.

(3) Use a basket hitch or weave tie to tie wire lines to the top of this tripod. Never tie wire lines in arctic areas. Bending the lines will crack and break the insulation, causing a short.

(4) Use electrical insulation tape TL-600/U (polyethylene).

d. In the desert, there are other conditions that may cause concern. Field wire lines should last a long time with proper installation and maintenance. Since there are no trees or poles in the desert, lance poles may be used for aerial construction. Buried lines will give good service. They should be tagged more often and whenever a new reel of wire is spliced. Shifting sand will cover the lines and make location of the lines difficult.

e. In tropical areas, dampness and fungus growth will materially reduce the effective range of field wire lines. Therefore, construction techniques may vary from the norm. Selection of the best route for a wire line is extremely important to construction and maintenance. Ground reconnaissance is more effective than aerial reconnaissance, because dense jungle growth hides trails and roads from aerial observation.

f. In many instances, it may not be possible to avoid areas that have been chemically or biologically contaminated. In any case, personnel will be required to wear the mission oriented protection posture (MOPP) gear to accomplish their mission. The requirement to wear MOPP gear will significantly affect the rate at which work can be performed. MOPP gear causes physiological as well as psychological degradation.

(1) Voice communications while wearing the mask becomes difficult. Hearing is impaired. Field of vision is narrowed because of the mask and identification of personnel is difficult.

(2) For additional information, refer to FM 3-4 and FM 3-5.

12. If equipment is available, go out and practice installing the wire line using as many of the means of construction as possible. It is imperative that you learn these techniques because they will save you time and maintenance work later on. Make sure you complete the line and install another TA-312/PT on the other end. Be sure to check the line for errors and tagging and be sure enough slack is placed in the line where needed.

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## LESSON 1

## PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any item incorrectly study again that part of the lesson which contains the portion involved.

1. Who is responsible for accident prevention?

   A Each soldier

   B. Medical personnel only

   C. Unit first aid personnel

   D. The commander

2. Is it advisable to give an unconscious person liquids?

   A. No

   B. Yes

3. What should be done with the injured wireman?

   A. Carry him to the road

   B. Lean him against a tree

   C. Check the injury

   D. Place him in a reclining position

4. What is the proper procedure for treating a closed fracture?

   A Stop the bleeding

   B. Apply some dressing

   C. Apply a splint

   D. Place the bones back inside

5. Your team member has become a victim of electric shock. What action should you take?

A. Lift the wire off the victim

B. Pull the victim clear with a dry rope

C. Look for a way to turn off the electricity

D. Run for help a fast as you can

6. There are several reels on which the wire can be wound. What is the primary reel used for WD-1( )/TT.?

A DR-3

B. RL-159/U

C DR-5

D. DR-8

7. What is the nomenclature of the knife in the TE-33 kit?

A. TL-13

B. TL-19

C. TL-27

D. TL-29

8. How many strands of steel are in the WD-1( )/TT?

A Three

B. Four

C. Five

D. Six

9. What is the attenuation per mile for wet WF-16/U?

   A. 2.0

   B. 2.2

   C. 2.4

   D. 2.6

10. What is the nomenclature for the two-man axle?

   A. RL-8

   B. RL-19

   C. RL-27

   D. RL-159

11. How many brakes are needed for the RL-31( )/G with a split axle?

   A. Two

   B. Three

   C. Four

   D. Five

12. What is the nomenclature for the gaff gage?

   A. TL-134

   B. TL-144

   C. TL-154

   D. TL-164

13. What is the distance the installer should use when installing wire lines on power poles?

A. 2 to 3 feet

B. 4 to 6 feet

C. 3 to 7 feet

D. 5 to 8 feet

14. When lashing lance poles together for increased height, what is the length of the overlap?

A. 2 feet

B. 3 feet

C. 4 feet

D. 5 feet

15. When installing a TA-312/PT for point-to-point lines, which position on the selector switch is used?

A. CB

B. CBS

C. LB

D. DC

16. When using a buried road crossing, what is the distance from the road to the stake?

A. 1 foot

B. 2 feet

C. 3 feet

D. 4 feet

17. What size drip loop is placed in the wire when installing a TA-312/PT vertical and the wire installation is aerial?

A. 3 inches

B. 4 inches

C. 5 inches

D. 6 inches

18. What is the height requirement for crossing a secondary road?

A. 12 feet

B. 14 feet

C. 16 feet

D. 18 feet

19. At what angle are the stakes placed for guying lance poles?

A. 25 degrees

B. 30 degrees

C. 45 degrees

D. 60 degrees

20. When tagging a wire line at a change of construction, what is the distance from the stake to the tag?

A. 6 inches

B. 5 inches

C. 4 inches

D. 3 inches

21. How far beyond the road should the trench extend for a buried road crossing?

A. 1 foot

B. 1 1/2 feet

C. 2 feet

D. 2 1/2 feet

22. What type of tape is used in the arctic?

A TL-300

B. TL-400

C. TL-500

D. TL-600/U

## LESSON 1

## PRACTICE EXERCISE

## ANSWER KEY AND FEEDBACK

| Item | Correct Answer and Feedback | |
|---|---|---|
| 1. | A. | Each soldier (Part A, page 1-2, para 1) |
| 2. | A. | No (Part A, page 1-3, para 3, tenth bullet) |
| 3. | D. | Place him in a reclining position (Part A, page 1-2, para 3, first bullet) |
| 4. | C. | Apply a splint (Part A, page 1-4, para 5a, second bullet) |
| 5. | B. | Pull the victim clear with a dry rope (Part A, page 1-3, para 4, second bullet) |
| 6. | B. | RL-159 (Part B, page 1-7, para 4b) |
| 7. | D. | TL-29 (Part B, page 1-9, para 7) |
| 8. | A. | Three (Part B, page 1-4, para 2, first bullet) |
| 9. | D. | 2.6 (Part B, page 1-5, Table 1-1) |
| 10. | C. | RL-27( ) (Part B, page 14, para 5) |
| 11. | A. | Two (Part B, page 1-10, Figure 1-8) |
| 12. | B. | TL-144 (Part B, page 1-11, para 9b) |
| 13. | B. | 4 to 6 feet (Part C, page 1-22, para 7h) |
| 14. | D. | 5 feet (Part C, page 1-24, para 9a) |
| 15. | C. | LB (Part C, page 1-20, para 3b) |
| 16. | C. | 3 feet (Part C, page 1-29, Figure 1-21) |
| 17. | D. | 6-inches (Part C, page 1-21, para 7) |
| 18. | B. | 14 feet (Part C, page 1-24, para 9a) |
| 19. | C. | 45-degrees (Part C, page 1-24, para 9b(5)) |

| Item | Correct Answer and Feedback |
|---|---|
| 20. | A. 6 inches (Part C, page 1-24, para 9b(7)) |
| 21. | C. 2 feet (Part C, page 1-25, para 9e(1)) |
| 22. | D. TL-600/U (Part C, page 1-30, para 11c(4)) |

## LESSON 2

MAINTENANCE

Critical Tasks: 113-588-0005
113-588-3022

## OVERVIEW

LESSON DESCRIPTION:

In this lesson you will learn how to make an expedient splice using telephone cable WD-1( )/TT or WF-16/U. You will also learn the procedures used to troubleshoot a telephone line using accepted practices that are expedient and return the line to an operational status as fast as possible.

TERMINAL LEARNING OBJECTIVES:

ACTION: Repair telephone cable WD-1( )/TT or WF-16/U, and troubleshoot a telephone line.

CONDITION: If you do not have access to the equipment, you only need this subcourse. If access is available, you will need a training area, telephone cable WD-1( )/TT or WF-16/U, installed telephone line, TA-312/PT, TL-13A, electrical or friction tape, and assistants at each end of the line.

STANDARD: Standard is met when knowledge of the skills required is demonstrated by correctly answering 70 percent of the questions on maintenance.

REFERENCE: The material contained in this lesson was derived from TC 24-20

## INTRODUCTION

Knowledge of the correct procedures for repairing telephone cable and returning the line to an operational status is one of the measuring devices a commander uses in evaluating soldiers under his command.

## PART A- SPLICING WD-1( )/TT

1. The strongest part of a communications link is its weakest point, and at times you will find that this will also apply to your field wire lines. This section will cover splicing and repairing field wire. You will learn the procedures to repair WD-1( )/TT first since it is the easiest to use and most common wire found in units today.

2 The expedient splice will be used because all repairs done to a line in the field have to be an expedient method of restoring communications. Expedient means suited to the circumstances or situation; a means to an end; a device used in an emergency; makeshift. The expedient splice fits all those definitions.

3. You have to learn the correct procedure to make an expedient splice.

a. Cut the ends of the wires even; straight across. (See Figure 2-1.)

b. Separate the conductors.

c. Cut one conductor of each pair 6 inches shorter than the other. Use the length of the TL-13A to measure. This is necessary so that the bare wires do not touch. (See Figure 2-1.)

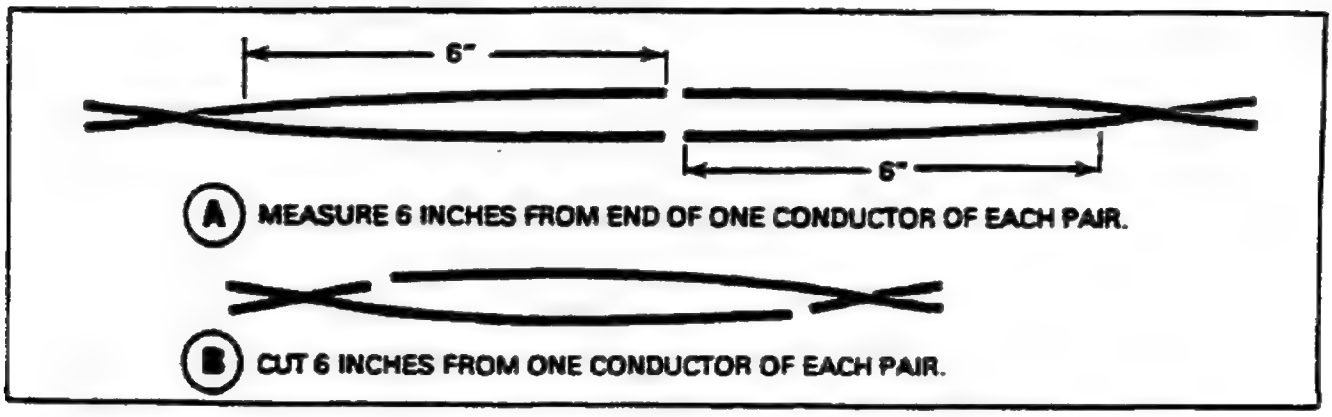


Figure 2-1. Conductors staggered for splicing.

d. Remove the insulation. Remove 1 to 2 inches at a time being careful not to cut any of the wires. If you do cut any wires, start over. Keep 1/2 inch insulation on the end of the wire to keep the individual wires together. (See Figure 2-2.)

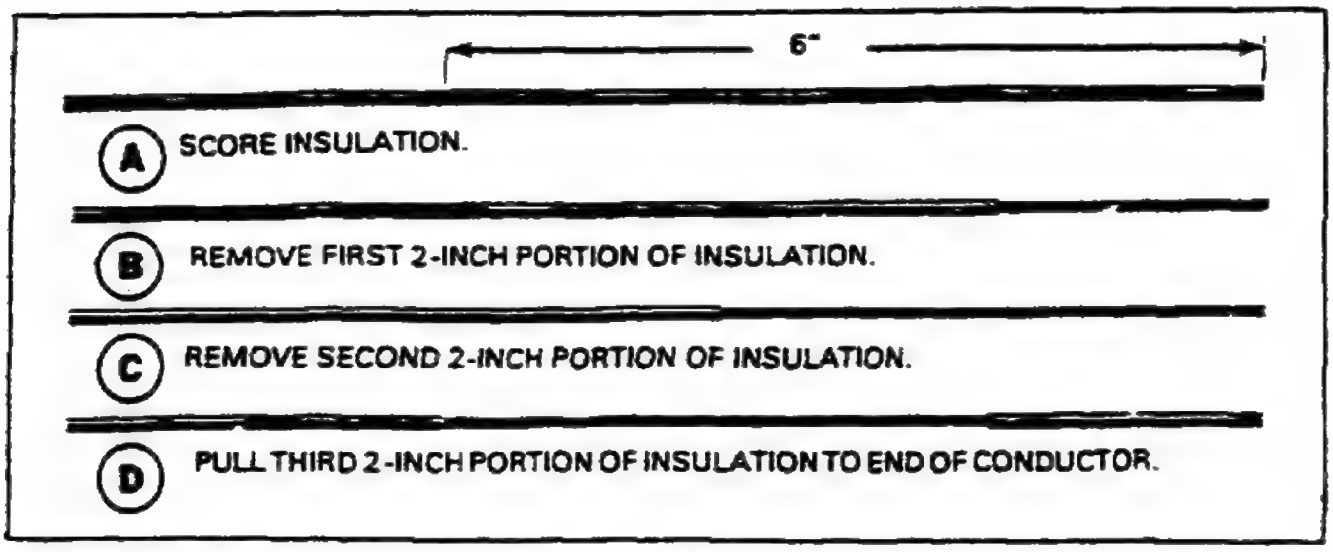


Figure 2-2. Removing insulation from field wire conductors.

e. You are now ready to join the broken conductors. To do this, use a square knot. To tie the square knot, join the end of the long conductor of one pair and the end of the short conductor of the other pair after restoring the normal twist of the conductors. (For WD-1A/TT, twist conductors where they were separated.) Twist conductor 1 over and under conductor 2 to form the first loop (A, in Figure 2-3). Twist conductor 1 over and under conductor 2 to form the second loop of the square knot (B, in Figure 2-3. Pull the knot tight, leaving a 1/4-inch opening in the square knot and a 1/4-inch space between the knot and the insulation (B, in Figure 2-3).

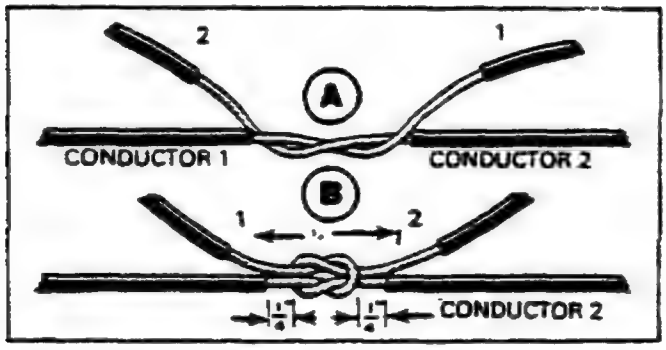


Figure 2-3. Tying square knot in field wire.

f. To seize the knot, when seizing wire is available, insert a 6- to 8-inch length of seizing wire through the center of the square knot and tighten the knot (A, in Figure 2-4). Bend the seizing wire at its center. Use half the wire for wrapping to the right. Take several close turns with the seizing wire, both to the left and to the right behind the square knot (B, in Figure 2-4). Cut the excess ends of the conductor flush with the insulation. Continue the seizing wire wrap, to the left and to the right of the square knot, until two turns are taken on the insulation. Cut the ends of the seizing wire and press them down into the insulation (C, in Figure 2-4).

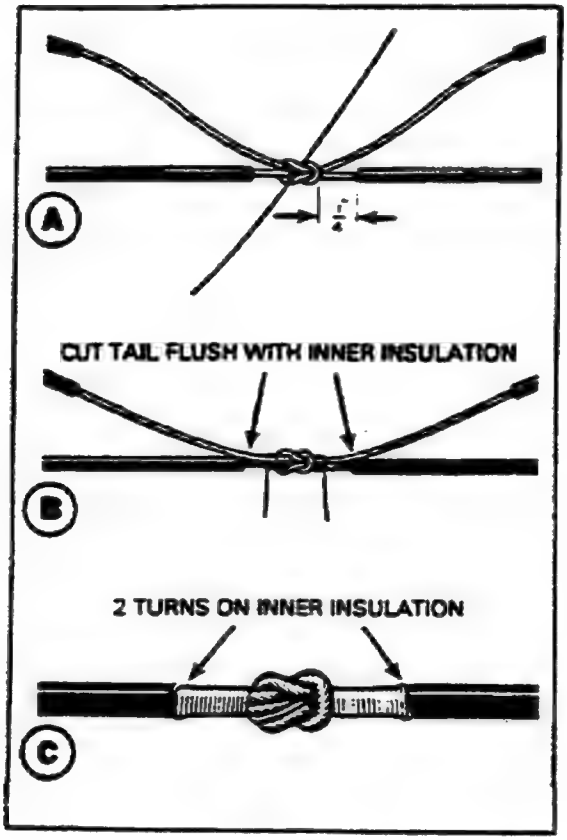


Figure 2-4. Square knot with seizing wire.

g. When seizing wire is not available, use the copper strands of the conductor to seize the square knot. After the knot has been tied and pulled tight, remove the insulation from the end and separate the three steel strands from the four copper strands (A, in Figure 2-5). (Copper strands will remain bent when flexed.) Cut the steel strands flush with the ends of the insulation (B, in Figure 2-5). Form an "X" over the square knot with copper strands. Cross the left-hand end of the copper strands to the back of the knot, take it down under and bring it up from lower left to upper right (C, in Figure 2-5).

Wrap several tight turns over the bared portion of the right-hand conductor from the edge of the knot. Continue wrapping until at least two turns have been made on the insulation. Cut the excess ends of the copper strand. Be sure to wrap the loose end around the wire to eliminate two separate wires. Repeat the seizing operation with the right-hand end of the copper strands again do the same as the left side but bring the wire up from bottom right to upper left. Cross over the crest of the square knot and wrap two turns on the insulation of the left-hand conductor. The entire length of the competed splice is approximately 3/4 inch (D, in Figure 2-5).

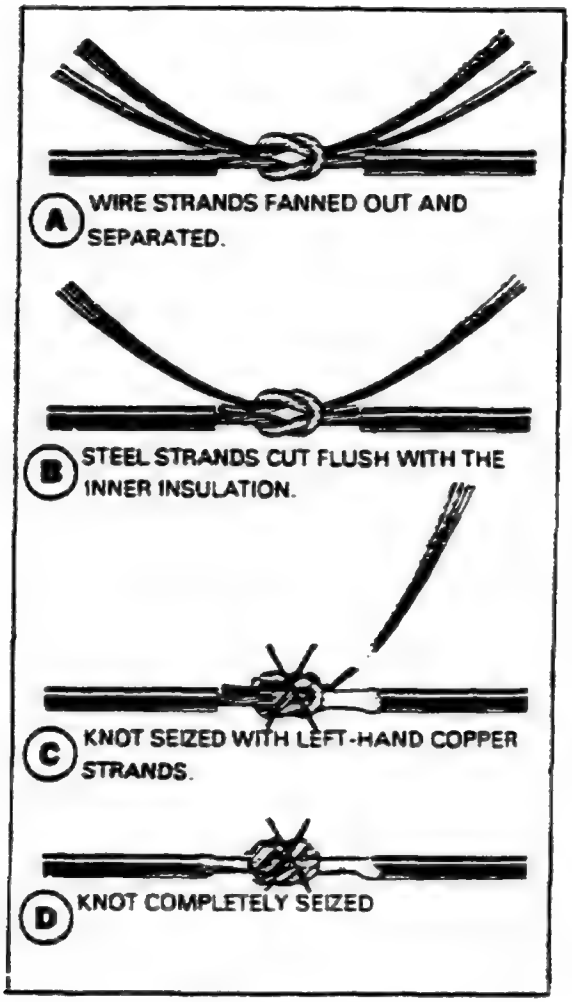


Figure 2-5. Square knot without seizing wire.

h. To tape the splice with electrical insulation tape, start taping at the center of the splice (A, in Figure 2-4). Use a steady pull and tape about 1 1/2 inches beyond the insulation at one end. Work the tape back over the knot to about 1 1/2 inches beyond the insulation on the opposite side. Finally, work the tape back again to the center of the splice (A, in Figure 2-6).

i. When taping the splice with friction tape, start at either end about 1/2 inch beyond the electrical insulation tape. Continue the taping to a point about 1/2 inch beyond the electrical insulation tape on the opposite end (B, in Figure 2-6).

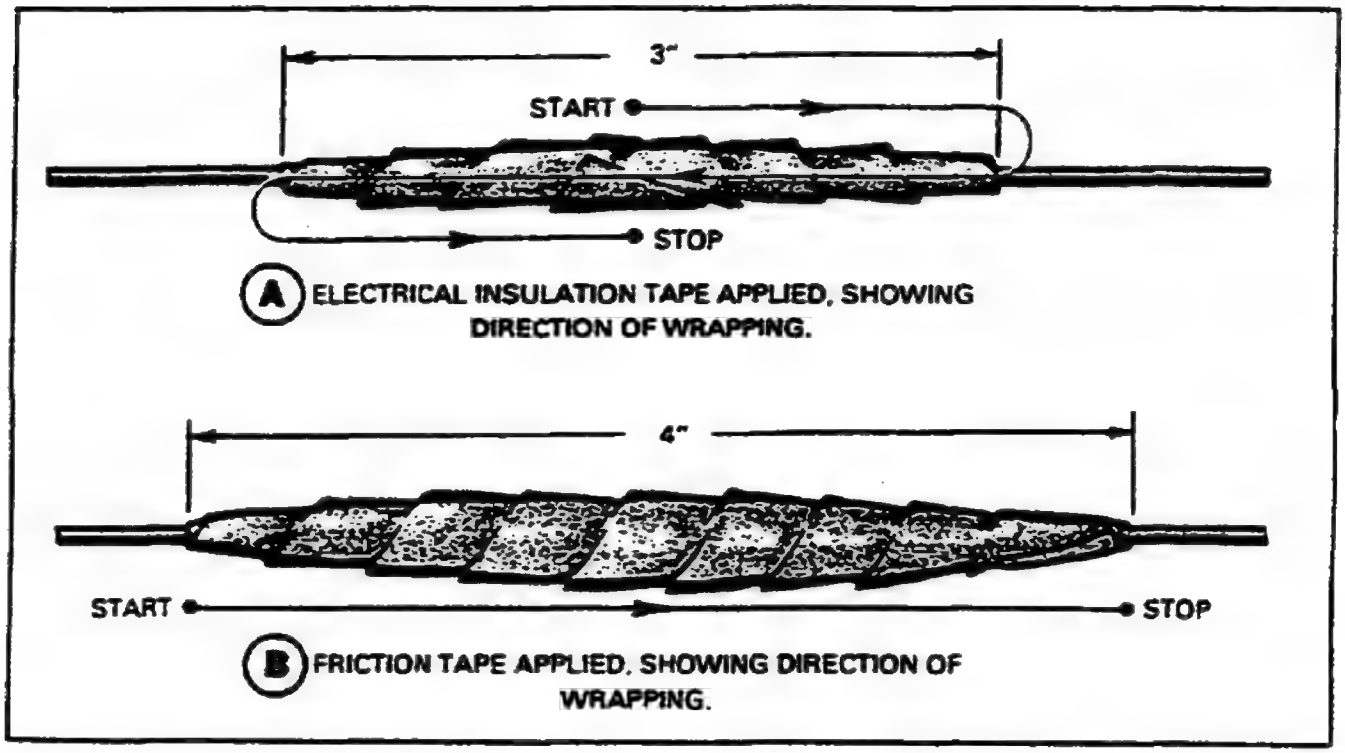


Figure 2-6. Applying electrical insulation tape and friction tape.

j. Now get a 2-foot piece of WD-1( )/TT, the TE-33 kit, insulation tape, and friction tape. Practice making the splice until you can do it like it was described.

## PART B - SPLICING WF-16/U

1. You must also know how to make a good splice using the WD-1( )/TT and WF-16/U. That is what we are going to discuss now.

2. WF-16/U telephone cable is composed of all copper strand wire. It is fine and does not have much tensile strength. In addition to just using the square knot, you have to make another knot first.

a. The knot needed is the single sheet bend knot using all four conductors. It is easy once you have practiced several times. At this time, if you have access to the equipment, get a 2-foot piece of WF-16/U and tie a knot in the center so the four wires stay together. Make a small loop at one end. Take the other end and place it over the top, then under and over the wires and down through the loop and pull it tight. (See Figure 2-7.)

b. Secure the knot with tape. Practice that tie until you can do it without thinking. It is not important to tape it each time you make it. You will only tape it when you are ready to continue splicing the WF-16/U.

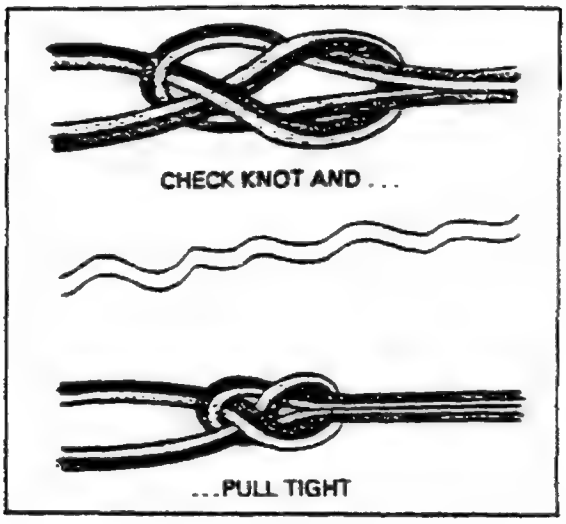


Figure 2-7. Tie single sheet bend.

3. At this time you should be ready to do a complete splice. Make the single sheet bend knot, but this time have at least 6 inches of the end available. The ends could be shorter, 3 inches. The extra length allows for error. Split each pair of conductors back 3 inches. Be careful not to damage the wires. Remove 3 inches of insulation from each end of the wires. Remember, now you are working with four wires on each end. The colors are important. Connect one green wire to its opposite green wire with a square knot. Tape the bare wires. Now connect the other green wires the same way. There should be the brown wires to connect together. Do those the same way you did the green wires. Once you have all four wires spliced and taped, you now put those taped wires together with the tape on the single sheet bend knot and tape it all together. (See Figures 2-8, 2-9, and 2-10.)

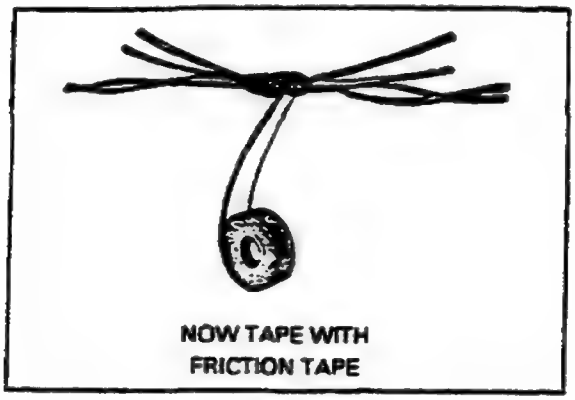


Figure 2-8. Tape knot with friction tape.

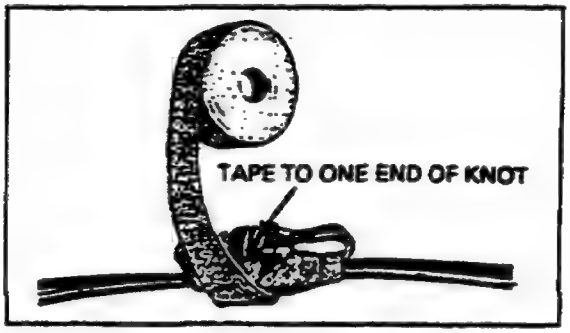


Figure 2-9. Tape loop to knot.

Figure 2-10. Complete field expedient splice.

4. At this time, if available, get another longer piece of WF-16/U and practice making the splice several times.

5. There is another method for splicing WF-16/U. It uses a tool known as an E9B crimper with U1R connectors. You still make the single sheet bend knot. But after you split the conductors you insert the green pair in each end, hold it tight so it doesn't slip, and crimp it with the E9B. Then do the same with the brown wires. Not all units have the crimpers so the expedient method is used by most personnel. (See Figures 2-11 through 2-15.)

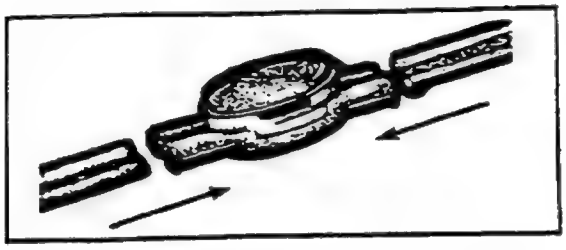

Figure 2-11. Insert conductors in UIR.

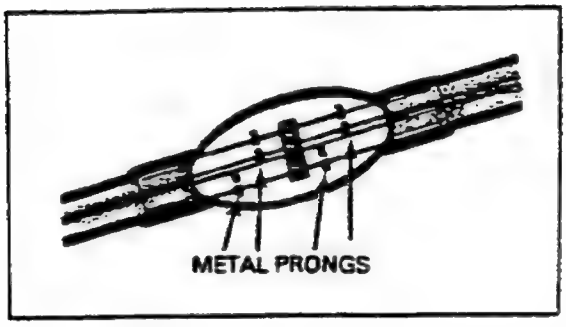


Figure 2-12. Conductors passing metal prongs.

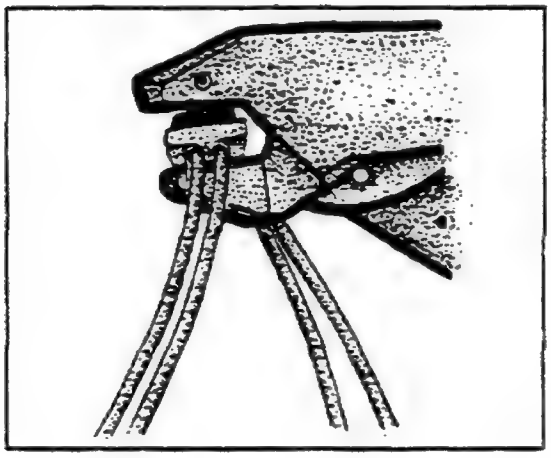

Figure 2-13. Center UIR in E9B crimper

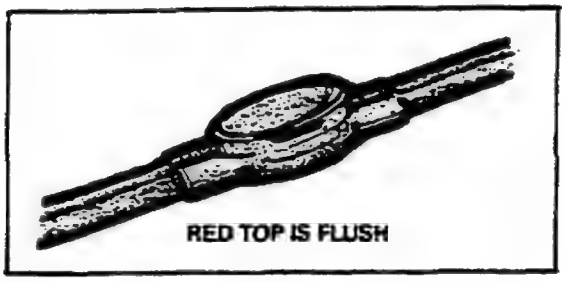


Figure 2-14. Press E9B crimper to flatten red top.

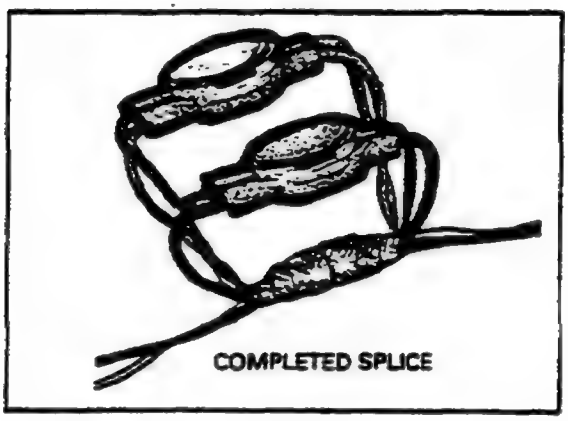


Figure 2-15. Complete UIR splice.

## PART C - TROUBLESHOOTING

1. The telephone cable WD-1( )/TT that you have installed will more than likely develop trouble at some time. There could be several things wrong. It could have been cut. It could have been pulled along the ground and the insulation rubbed off. Maybe someone else worked on it and spliced the wrong wires together in the dark. There are problems that can befall the line and now it is up to you to find the trouble and repair it.

2. There are certain procedures to follow when you are looking for trouble. We will be discussing those procedures and what you have to do about the problem. You have probably figured out what you have to do to repair the line, so center your thoughts on finding the problem.

3. As each problem is discussed, think about the line that is already installed. It might be a short line or it might have been a 1/2 mile or longer line. In any case, these problems can arise in any line.

4. The first problem you will try to understand is the open. This simply means that either one or both conductors have been broken or cut. It is usually found in long spans and most often in the aerial construction. Why? Look at the strain you have on the wire from support to support. It might be broken anywhere in the span or it might be broken where you secured it to the support. Consider also the fact that when the line was installed there could have been a splice in the aerial span. If that splice was not done properly, it could have broken. There are many ways a wire might have been cut. The aerial span might not have been high enough over the road and a vehicle with a tall load went under it and caught the wire, stretched it, and caused it to snap.

a. Do not forget about the surface and buried construction. On the surface construction, many things could happen to cause an open. Someone might have needed some wire to secure an area; run lights to a tent or an extension to another telephone; or maybe a vehicle drove over the wire causing it to break.

b. Buried cable can also create problems which would cause an open in the line. Sharp objects in the trench could have worked their way down and cut the wire. It is also possible that constant vehicle traffic, either wheeled or tracked, in and out of a node can cause damage to your line.

5. Now look at short circuits. These may be caused by the insulation being worn off and the bare conductors touching each other. How could the insulation be worn off? Was the line thrown through the tree and resting on tree limbs? Was it windy causing the tree to sway back and forth? The rough bark could rub the insulation off very easily. Don't forget about the splices in the line. The tape could have come loose and fallen off and the poorly made splice could cause the short.

6. Another reason for trouble on the line could be a grounded circuit. No, it is not attached to a ground rod. This means that the insulation was worn off and one or both conductors may be touching the ground. It could be in a puddle of water after a rain and the water seeped through the tape and got into the splice. The traffic over the road could have worn the insulation off. Again you would be looking for a ground.

7. There is also the problem of picking up the telephone only to hear someone else on the line who doesn't belong there. That is known as a cross. Somebody spliced the wrong wires together and your private line between point A and B is now a private line from point A to point C. This could also happen if several lines went through a tree together and the insulation has rubbed off. Not only could you have a possible ground but a cross as well.

8. Now that you know what problems may occur, you should be able to identify them by doing a check on the line. We will discuss symptoms of trouble on the line.

a. An open circuit disrupts or opens the line completely. There is no way for you to make contact with anyone. It does not matter if one or both conductors are broken. There is no way for you to make contact until you find the open. If you put a TA-312/PT on the line and turn the crank, it will be very easy to turn with no drag. You will have the same result if the telephone is not connected to a line.

b. A short circuit is just the opposite. If the TA-312/PT is on the line and you turn the crank, it will turn hard and in an uneven motion. A low resistance short will disrupt communications completely whereas a high resistance will cause weak transmissions and signaling. The telephone is the best way to determine the problem.

c. A grounded circuit will give different symptoms. If both conductors are grounded, communications will be disrupted and you might think you have a short. Consider the splice in the water. If you have a grounded circuit there could be noise or a hum on the line and you might think it is an AC power hum.

d. Crossed circuits are easy to identify. Strange people are on the line that should not be there. If the line is a point-to-point line, the user of the telephone will know if there is a strange person n the line. It is your job to locate the problem.

9. Keep one thing in mind when troubleshooting. NEVER interrupt communications or any system that is working to test it. You only work on troubleshooting when there is trouble on the line and you are sent to find and fix it. Do not disconnect any line for any type of routine check. You work only on those lines identified as having trouble.

10. When trouble is identified on a circuit, the wireman will be the one to determine the fault, find it, and fix it. You must remember that priority lines sometimes have to be rerouted while you are determining the problem. Those high priority lines have that same high priority when trouble is identified on the line. To aid in troubleshooting, sometimes you will be instructed to put in duplicate or spare lines.

11. Locating and clearing troubles require you to have some knowledge of the installation of the line. Usually the person who installed the line does the troubleshooting, if available. Why? Who knows the most about the line and where possible trouble could be? The installer. If it is a two-wire line, WD-1 ( )/TT, you will need a good TA-312/PT, some tape, and your TE-33 kit.

12. Go to either end to start troubleshooting. Use the instrument there first. This is to determine if the trouble is in the telephone. Then try your telephone. If the same problem exists, their telephone is probably good. Make the determination of the trouble from the symptoms we have discussed.

13. What do you do? There has to be a system or procedure on locating the trouble. Several might work but one that does it easily is the one you will use. After you checked the instrument at one end, you would then go to the halfway point. If the line is an open you could use your TL-13A to remove some insulation, connect the telephone, and then ring it down. Who does not answer? The trouble lies in that direction. Before you depart the area be sure to tape those bare wires. But wait, what do you do if the line is a short? The only thing you can do is to cut the line and test first in one direction and then in the other. Which ever end does not answer is the direction of the trouble. Splice the wires together before departing in that direction.

14. How far do you now go? Again, split the difference and go half way. Repeat the steps you took before and test the line. Either the trouble is further down the line or you passed it. Again split the difference until you narrow it down to a short distance and then you can walk the line to locate the trouble. Remember too, the trouble could be the instrument at the distant end. Your job is to be sure the line is capable of communications from one end to the other.

15. Of course, we are always looking for short cuts to the job. There are none. Sometimes you just have to walk the line and look for the trouble. It is usually in the most inconspicuous location.

16. If you have access to the equipment, have your supervisor put trouble on the line and then have you find it. You will need two additional people to help you. There must be someone at each end to answer the telephone.

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## LESSON 2

## PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. When taping a splice, how far beyond the insulation should you tape?

   A. 1 inch

   B 1 1/2 inches

   C. 2 1/2 inches

   D. 3 inches

2. You are preparing WD-1( )/TT for a splice. How much shorter is one conductor than the other?

   A. 2 inches

   B 4 inches

   C. 6 inches

   D. 8 inches

3. What is the model number of the crimper Used with WF-16/U?

   A. E9A

   B. E9B

   C. E9C

   D. E9D

4. You are troubleshooting a telephone line. The telephone turns very easily. What is the problem?

A. Cross

B. Ground

C. Short

D. Open

5. If the telephone crank turns hard, uneven, or jerky, what is the trouble?

A. Cross

B. Ground

C. Open

D. Short

6. If the telephone has noise and a hum on the line, what is the problem?

A. Cross

B. Ground

C. Open

D. Short

7. You start troubleshooting at one end of the line. You make contact with your telephone. What is the problem?

A. Distant end

B. Line in use

C. User's instrument

D. Operator problem

8. What is the distance between the square knot and the insulation?

   A. 1/4 inch

   B. 1/3 inch

   C. 1/8 inch

   D. 3/4 inch

9. When seizing the knot, how many turns are on the insulation?

   A. Two

   B. Three

   C. Four

   D. Five

10. What is the makeup of WD-1( )/TT?

   A. Two copper and five steel

   B. Three copper and four steel

   C. Four copper and three steel

   D. Five copper and two steel

## LESSON 2

## PRACTICE EXERCISE

## ANSWER KEY AND FEEDBACK

| Item | Correct Answer and Feedback | |
|---|---|---|
| 1. | B. | 1 1/2 inches (Part A, page 2-5, para 3h) |
| 2. | C. | 6 inches (Part A page 2-2, para 3c) |
| 3. | B. | E9B (Part B, page 2-8, para 5) |
| 4. | D. | Open (Part C, page 2-12, para 8a) |
| 5. | D. | Short (Part C, page 2-12, para 8b) |
| 6. | B. | Ground (Part C, page 2-12, para 8c) |
| 7. | C. | User's instrument (Part C, page 2-13, para 12) |
| 8. | A. | 1/4 inch (Part A, page 2-3, para 3e) |
| 9. | A | Two (Part A, page 2-4, para 3f) |
| 10. | C. | Four copper and three steel (Part A, page 2-4, para 3g) |

## LESSON 3

RECOVERY AND SERVICE

Critical Tasks: 113-588-1104
113-588-3022

## OVERVIEW

LESSON DESCRIPTION:

In this lesson the correct procedures for recovery and servicing telephone cable WD-1( )/TT or WF-16/U will be discussed. Wire is used over and over again. For this reason, you must be able to recover and service the wire and prepare it for the next time you have a reason to use it.

TERMINAL LEARNING OBJECTIVES:

ACTION: Recover a telephone cable line and service and test recovered wire line.

CONDITION: Given lesson material, pencil, and paper. If you do not have access to the equipment, you only need this subcourse. If access is available, you will need a training area, a preinstalled WD-1( )/TT line, shovel, hammer HM-1 or rubber mallet, RL-159/U with WD-1( )/TT, RL-31/U, gloves, linesman bag, recovered wire on RL-159/U, empty RL-159/U, two RL-31( )Gs, TL-13A, TA-312/PT, tape, two each BA-30s, wire tags, grease pencil, and clean rags.

STANDARD: Standard is met when knowledge of the skills required is demonstrated by correctly answering 70 percent of the questions on recovery and service.

REFERENCE: The material contained in this lesson was derived from TC 24-20.

## INTRODUCTION

Equipment is very expensive. Recovering and securing the wire we use in an operation will save money. Wire can be used over and over again. The number of times it can be used depends on the number of splices it has.

## PART A - RECOVERY

1. The line has been installed and used within a system. It has provided a valuable service to a customer. When the service is no longer needed it is necessary to recover all the equipment used in the installation. The reason for this is to have it available when there is a new requirement to install another telephone line. There is no endless supply of equipment and what is available must be used over and over again.

2. There are some very important steps to be considered before attempting to recover the line. These steps will be explained and once you are thoroughly familiar with them it will be up to you to go out and recover the line you have installed.

3. In order to recover the line it is necessary to know where it starts, where it ends, and how long it is. This is important because this information will determine what equipment will be required to recover the wire line.

4. Before proceeding to recover the line, you should verify that the circuit is no longer needed and that the telephone on the line belongs to you. After doing this, it is a good idea to ring down the line before it is disconnected. It is possible that the party at the other end is not aware that the line is no longer required and is about to be removed.

5. The line is cleared for removal. Remove the instrument at the starting point. Remove the tag and any other means of identifying the line. Take the batteries out of the telephone. Remove the tag that secured the line and move it outside where you can do your work.

a. Set up the RL-31( )/G on a ground mount or on a vehicle, depending on the length of the line. Splice the line to the wire on the RL-159/U. If there is no wire on the RL-159/U, pass about 12 to 16 inches of the wire through the side of the reel to the outside and tie a good knot to keep it from being pulled back onto the reel.

b. Before winding the wire on the reel, be sure the wire is ready. Wire that is still tied in place cannot be recovered. Have all ties been removed or will they be removed as you come to them? Has aerial installation been removed? If not, you must climb the pole or tree, untie the line, and drop it to the ground.

c. At the buried road crossing remove all tags, ties, and stakes. Be very safety conscious here because there will probably still be traffic using the road. Dig the line up. The time required depends on how deep it was buried and how long it has been there. After the wire line is recovered, restore the road to its original condition.

d. At aerial road crossings that have lance poles PO-2, you must still be very safety conscious about traffic. When the way is clear, have someone go to the other side of the road. Lower the lance poles very carefully before trying to remove the wire line. Remove all tags, ties, and stakes and be sure the wire is free on both sides of the road. Move to the side of the road in the direction the wire is going and wind the wire on the reel. Before proceeding, be sure all equipment has been recovered and that nothing has been left behind. Continue recovering the wire.

e. When you reach the end of the line remove all tags, ties, and the instrument. Remember to remove the batteries from the telephone. When all wire line is recovered and before storing the equipment, it is a good idea to run a ringdown check on the recovered line to be certain that none of the splices broke or loosened while you were recovering the line.

6. If you had access to the equipment and had installed a wire line earlier, go out and recover the line you installed.

## PART B - SERVICING

1. Servicing the recovered wire line is a very important step. This prepares the wire line for the next installation and you know it is ready for use.

2. The following equipment is needed to service a wire line:

a. Two RL-31( )/Gs spaced about 10 feet apart.

b. The RL-159/U with the recovered wire.

c. An empty RL-159/U on which to wind the wire.

d. Electrical or friction tape.

e. Tool kit TE-33.

f. Two telephones TA-312/PT with BA-30s.

g. Gloves.

h. Bucket of water and some rags.

3. You will need one additional soldier to help you. That individual will turn the crank on the RL-31( )/G to wind the wire from the full RL-159/U to the empty one while you check and service the wire.

a. Secure the wire to the empty reel RL-159/U with approximately 12 to 16 inches of wire protruding through the hole on the side of the reel. Tie a good knot to keep it from being pulled back onto the drum. Be sure the insulation is removed from the ends since you will need to connect a telephone to the wire to check it.

b. Have your helper slowly turn the crank to move the wire from the full reel to the empty one. As the helper slowly turns the crank, you will guide the wire onto the reel. Wear your gloves. As the wire passes through your hands clean the wire as needed and check the insulation for abrasions. If the insulation is cut or damaged, stop and repair or tape that spot. This will help prevent trouble later on.

c. Check each splice very carefully. If the tape is loose, you should remove it. Check the splice and retape it if it is good. If the splice is loose, cut it out and resplice the line. Be sure you do both conductors so the wire retains its original look. You don't want one conductor shorter than the other.

d. If there is a spot where there are several splices within a short distance, two or three splices within 10 to 15 feet, cut out that section and make one new splice. The more splices you have in the wire, the greater the possibility of having trouble the next time you use it.

e. After each splice and at the end of the wire, test the line for opens, shorts and high resistances. Use the TA-312/PT you have at your location for the test. If you cannot ring through or the crank turns hard and jerky, you have a problem and you must rewind the wire and recheck it. The line must ring through and you should be able to talk on it with no problems.

4. If the wire passes the physical and electrical tests and repairs/splices are good, keep in mind that the number of splices will determine if the wire is usable. If the line has no more than four splices per conductor per 1/2 mile, it can be considered fully serviceable and you can tag the line and identify it as Class A. Put the date on the tag and initial it.

5. If the wire has more than four splices per conductor per 1/2 mile, it is considered serviceable but should be tagged Class B. This wire should be used only in the zone of interior or for training purposes.

6. After the wire has been allowed to dry, it should be placed with other wire of the same class and stored for use at a later date.

7. If the line was installed using an MX-306A/G do not try to refill it. Turn it in to supply for return and refill. The wire that came from the MX-306A/G can be recovered and serviced the same way as the wire from an RL-159/U.

8. If you had access to the equipment and had recovered a wire line, service the wire you recovered.

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## LESSON 3

## PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answers with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. You have been told to recover the line. What should you do before actually removing the line?

   A. Arbitrarily remove the line

   B. Go to both ends to check on it

   C. Start winding the line on your own

   D. Verify the circuit is not needed

2. How many personnel are needed to properly service a wire line?

   A. One

   B. Two

   C. Three

   D. Four

3. What is done with the tags on the wire line?

   A. Erase identity marks

   B. Nothing, they stay attached

   C. Remove them

   D. Wind them in with the wire

4. You are servicing a wire line. There is an area where three splices are close together. What do you do?

A. Check each splice

B. Make a special note on the tag

C. Prioritize the wire for immediate reuse

D. Remove them and make one splice

5. The line is recovered and serviced. What is the final step before storing the reel of wire?

A. Conduct a physical test

B. Conduct an electrical test

C. Identify the number of splices

D. Determine if it is Class A or B

## LESSON 3

## PRACTICE EXERCISE

## ANSWER KEY AND FEEDBACK

| Item | Correct Answer and Feedback |
|---|---|
| 1. | D. Verify the circuit is not needed (Part A, page 3-2, para 4) |
| 2. | B. Two (Part B, page 3-4, para 3) |
| 3. | C. Remove them (Part A, page 3-2, para 5) |
| 4. | D. Remove them and make one splice (Part B, page 3-4, para 3d) |
| 5. | D. Determine if it is Class A or B (Part B, page 3-4, paras 4 and 5) |